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AND

DEPARTMENT OF AGRICULTURE

Nos. 293 to 318

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Ontario Department of Agriculture

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TORONTO, ONTARIO, MARCH, 1923

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FEEDING YOUNG LIVE STOCK

By L. STEVENSON, B.S.A., M.S.

FOREWORD

This circular was prepared as an aid to the many and youthful members of the Boys' and Girls' Clubs. Its scope has been limited to calves, colts, lambs and pigs, the four classes of stock that are of especial interest in club work.

A sympathetic understanding between the young people and their live stock is the first essential marking the highway to success. Without a sympathetic appreciation, live stock can not succeed.

THE IMPORTANCE OF FEEDING

Ontario has many excellent feeders and stockmen, men who are handling their stock in such a way as to be highly profitable. A visit to the large exhibitions will usually reward us with a display of fine animals, a large-sized sample of the cream of the country. If we go out to the stock yards we generally have an apportunity of viewing many carloads of live stock that bear but little resemblance to what we see at the exhibitions. Feed and care are largely responsible for the difference.

Animals grow big, men grow big and plants grow big, because they are well-nourished and fed. It does not just happen. An empty stomach never got either man or beast up to any respectable condition or weight. If we see well bred yearling animals, thin, scrawny and not larger than calves, we are

justified in concluding that partial starvation or lack of proper feeding has been responsible for their condition. During the past thirty years many highly bred imported animals of various breeds have been lost to the country through being sold into the hands of men who were indifferent feeders. Just how much Ontario has lost it is difficult to determine, but when the old boys tell us that the live stock of the country does not average as good to-day as it did thirty or forty years ago, perhaps we should do a little thinking. Ask any of the farmer stockmen of the past why the difference, and they promptly tell us that the average and below average farmer does not feed liberally, nor give the stock the bodily comfort that the old fellows did. A trip out to the stockyards will convince all that there is considerable truth in what the old fellows say.

The long autumn and winter period, followed by the spring season during which the grass is either covered or growing to grazing stage, leaves but five months of the year when outdoor feeding or grazing is both attractive to the animals and profitable to the stockmen. Seven months' feed must be supplied by human hands. The quantity must be ample and the quality good or maximum profits can not be expected. Domestic animals are kept for the purpose of converting plant products into human foods, dairy produce and meats; to do this converting the plant products or feeds must be supplied in quantity sufficient to keep the machine (animal) working to full efficiency. Big records in milk and beef production can only be made by supplying the materials from which they can be made. Animal products do not generate from nothing; there must be an abundance of a real something in the manger or in the pasture field.

The Feeder.

The ways of some people are such that they may attract or repel farm animals. The quiet, kindly, sympathetic individual will, as a rule, take care of and feed successfully whatever animals are given to his or her charge. The rough, cranky, ill-tempered or unsympathetic individual is, as a rule, a poor hand to feed domestic animals. If you listen to a discussion by farmers bearing on farm labour, you will hear these expressions: "That man is poison to horses"; "Your animals will always be unthrifty if you employ him"; or you may hear: "He is a splendid feeder"; "He loves live stock"; "Your live stock will improve if you employ him." Why the difference in people employed to feed live stock? Human beings differ in temperament considerably, and we can see just as great a difference in the product of their work or management of live stock. The successful feeder likes the work of feeding and the association of the animals he feeds. The feeder deals with a highly organized sensitive animal system, an animal system that is capable of being influenced by external factors. For instance, noise, rough treatment, cold, exposure to storms, worrying by dogs, and such like, are all known to have an evil influence on the nerves and digestive systems of domestic animals. If we attend the exhibitions, we will note that some one or two stockmen have their animals in better fit than the others. Study these successful feeders and note among other traits they show, indications of being kindly, good-natured and quiet men or boys, capable of bearing good-will toward domestic live stock. Poor feeding by people not having the required love or interest in the work, or the unfortunate condition of animals getting into the hands of men who keep them in the spirit of a necessary evil for imagined profit, is, in a large measure, responsible for so much scrub stock through the country. To be a successful feeder, the boy or girl must have a love for animals sufficiently strong to make any sacrifices required for the comfort and well-being of the calf, the pig or the foal.

FEEDING LAMBS

Mother's milk is the first and best food for lambs. If this is not available, then the milk of goats or cows may be used. If the ewe or mother sheep has been well fed on oats, bran, clover and few roots for at least a month before the birth of the lamb, there is little likelihood of a milk shortage for one lamb. Lambs that have unkind mothers usually need some assistance to obtain nourishment. The mother sheep can be held by hand or tied with a halter while the lamb nurses. This is usually not necessary for more than two or three days. The transfer of lambs from one ewe to another can be made at birth, or while the lamb is still very young, by fooling the ewe, who by the way, depends largely on the sense of smell to identify her offspring. Should a ewe have but one lamb, a day old, and it is desired to have her feed a second one, rub the two lambs together until they have the same smell, and then test the ewe's ability to identify. If a ewe loses her lamb and it is desired to have her adopt and feed another one, such can be done by removing the skin from the dead lamb and placing such on the back of the lamb that it is desired she should adopt. This must, of course, be done in a comparatively short time; by cutting a slit

A sheep club boy with Oxford ewe and her triplet lambs.
Bluegrass and shade, ideal for sheep.

in each corner of the pelt through which the legs of the living lamb may be passed, it is easy to keep the skin in place for a few days. Twin lambs frequently do not get sufficient milk for best development; the strong lamb will get more than its share. Close attention is necessary to make such adjustment as will insure the weak lamb getting a fair share. When lambs are not getting all the milk they need from their mother, provision should be made to supplement such by teaching the lambs to drink cows' milk from bottle or pan.

Hand-Feeding Lambs.

Lambs that have lost their mothers or have milkless mothers can be successfully reared by using goat or cows' milk in a rubber-nippled nursing bottle. The newly-born lamb requires a small quantity of milk at very frequent intervals. Two or three teaspoonfuls every hour for the first day, with a gradual increase as the lamb grows older. Many make the mistake of giving a newly-born lamb all the milk it will take at two or three feeds a day. This treatment is very frequently fatal. Keeping the feeding bottle clean and sweet, and using the milk from a fresh cow and feeding every hour or two until the lamb is four

weeks old, will generally give good results. Milk may be continued as a feed as long as the lamb will take it. Should bottle-fed lambs develop scours, this condition can be checked usually by heating the milk to boiling point and then cooling quickly. A teaspoonful of castor oil given with the milk is also an effective remedy.

Grain Feeding.

When the lambs are two or three weeks old, they will start nibbling at grain, hay or grass. At this time they should be encouraged to feed by way of placing choice bits of fodder and grain in a small feed trough where they can reach it without being disturbed by the older sheep. Bran, ground oats, cracked corn and oil cake meal are very desirable concentrates for lambs. Fresh water and salt should always be available in the pens, yards or pasture. The amount of grain to feed will depend largely upon the use that it is desired to make of the lambs. Lambs for the "hot house lamb" trade require liberal grain feeding. Those for breeding, or ordinary markets, should be limited within the bounds of profitable feeding. With lambs for exhibition, costs are sometimes of secondary importance and the grain feeding more liberal than it is with the lambs of the breeding or market type. Lambs that are grain fed from the beginning will reach market weight six to eight weeks earlier than those not receiving grain until the commencement of the fattening period. When grain feeding is too liberal, either before or after weaning, the lambs will depend upon the grain feeds, and not eat as much grass or other roughage as is in keeping with profitable feeding. The amount of grain to feed must be determined by the age of the lamb, the purpose for which the lamb is being reared, and the coarse feeds available. Grain feeding from the time that the lambs begin to feed is a profitable practice if the amount of grain fed per day does not reduce the lamb's appetite for grass and other coarse feeds. During the fattening period, the quantity of grain fed per lamb should generally not exceed one and a half pounds per day if the feeding is to be profitable. Good pasture grass, clovers, or rape should be supplied liberally to all lambs intended for the ordinary market or breeding. With hot house lambs, the coarse food is limited, and grains and milk are largely depended on for rapid gains.

Exhibition.

Lambs presented for exhibition at school or other fairs should, first of all, have been born early enough in the spring to be well grown by exhibition time. The lamb's fleece should be kept free of ticks and lice, burrs and dirt. During the season, a washing can be given, if necessary, at least two weeks previous to the show. Lambs that are kept up and fed in covered pens will show a better fleece than if they had been running out on pasture up to the last minute. The fleece should be neatly trimmed one week or more after washing, if washing is practised, and care taken to keep the fleece free of chaff and dust until the exhibition is over. In feeding for exhibition, variety in feeding stuffs should be sought in order to keep up the lamb's appetite, using oats, corn, wheat, bran, cracked peas, barley meal and oil cake meal for the grain portion of the ration, and good alfalfa or red clover hay and swede turnips as roughage. These feeds, if mixed to give a ration with a nutritive ratio of 1 to 6 or 1 to 7, will take care of the growth demands and fatten the lambs. Should it be desired to feed the lambs while running on pasture, the grain ration given can be used. The lambs should be handled sufficiently to make them tame enough to stand well when being exhibited. If more than one lamb is called for in a class, all in-

dividuals should be uniform in size, type, condition of fleece and body fleshing. Teach the lambs to stand straight and quiet, hold them by grasping gently beneath the jaws, catch by looping your arms about neck and thighs. Don't pull the wool; it spoils the fleece and hurts the lamb. Get the lambs used to being handled at least a week before the fair.

Causes of failure in lamb feeding.

1. Ewes not properly fed during pregnancy or after.
2. No supplementary feeds for the lambs.
3. Failure to properly dock and alter lambs.
4. No provisions against failure of pastures.
5. No protection from other stock.
6. Pastures infested with eggs or larvæ of stomach worm.
7. Failure to dip and destroy ticks and lice.
8. Failure to clip wool from inner thighs and udder of the ewe.
9. Using poor scrub stock.

Lambs of mixed breeding, better selection in parent stock needed.

Reasons for success.

1. Proper care and liberal feeding to ewe and lamb.
2. Supplementary feeding ample.
3. Wool removed from vicinity of udder of the ewe.
4. Ticks destroyed or prevented.
5. Using good vigorous stock of desirable type.
6. Ample supply of green forage.
7. Pastures and yards kept free of eggs or larvæ of stomach worms injurious to sheep and lambs.
8. Protection provided against fly nuisance.
9. Docking and altering performed at proper time.

FEEDING YOUNG PIGS

The feeding of the young pigs begins very early in their life, by way of being kind and considerate to the prospective mother. Liberal feeding on a well-balanced ration suited to the needs of the sow previous to the birth of the young is very essential if the little pigs are to be worth rearing and the sow in condition to supply ample milk for them. With the sow well nourished and given opportunity for exercise, she is the best equipped individual to undertake the task of rearing a litter of little pigs. After the little pigs arrive, everything should be done for their comfort and safety if they are to succeed as feeders. Clean, light pens, dry yard or grass lot, abundant sunshine and a well fed mother, usually mean success to the little pigs. When the young learn to feed at four weeks of age, provision should be made whereby they can feed at a small trough in an enclosure away from the sow. Small quantities of sweet skim milk in which wheat shorts have been mixed should be fed in small quantities and often, feeding a little less than the pigs will actually take. Pigs that have been feeding from the trough for two weeks or more can be weaned without a very serious set-back. The longer the pigs can remain with the sow the better it is for them, but such practice is not always profitable, so it is usual to wean the pigs when they are eight weeks old. Since pigs are hunting the ground surface or rooting for morsels of food, it is good practice to encourage such by scattering plump grain on the floor of the pen or yard. This causes the pig to take the exercise necessary to thrift. When the pigs have reached the weaning age of eight weeks, they should be completely separated from the sow. It is better to remove the sow and leave the young pigs in the pen that they have been used to, for a week, that their troubles may not all come at once. When the pigs have quite forgotten their mother, an ideal home for them is a colony house situated in an alfalfa, red clover, rape or blue grass pasture yard, where water, a wallow hole and shade are amply supplied. If the young pigs must be kept in the piggery, then everything should be done to provide dryness, protection from insects, a living temperature, ample room, cleanliness, comfort, sunshine and a ration suited to their needs. Green feeds should form a fair percentage of the total ration for pigs whether fed as a soiling crop or as pasture. The following mixed grain ration has proven very satifactory: wheat middlings, 25 pounds; shorts, 25 pounds; finely ground oats, 50 pounds; oil cake meal, 5 pounds; meat meal, 3 pounds. Pigs eight weeks old will require a pound or more per day. The quantity required for each day should be set apart and soaked for twelve hours or more, using no more water than is required for the soaking process. When ready to feed use five pounds of skim milk to each pound of meal. Feed sweet skim milk until the pigs are well weaned, then change to sour skim milk and continue to use such as long as possible. After the pigs are three months old, buttermilk can be used instead of skim milk with equal advantage. A change in the grain ration is also desirable at this age, and is most easily provided by adding a more fattening grain to the mixture already suggested for the eight-weeks-old pig. The following is very satisfactory: Corn or barley, 25 pounds; shorts, 50 pounds; wheat middlings, 25 pounds; finely ground oats, 50 pounds; oil cake meal, 8 pounds. Soaking to soften and thereby increase digestibility should be practised. The corn or barley portions of the ration should be increased gradually after the fourth month has passed, to give the pig an opportunity to fatten during the last two months of its life, should it be designed for the block. If intended for breeding purposes, the feeding is practically the same up to the fifth month. The "intended for breeding purpose" stock should be developed on a ration carrying more bone and muscle-

forming material than the standard fattening rations. More alfalfa, red clover, sweet clover, rape or blue grass can and should be used.

Winter feeding.

The success attained at pig feeding in the winter depends to a greater extent upon the skill of the feeder than does summer feeding, when weather conditions are favourable. Comfortable quarters which may be under the strawstack or in an elaborate pen; some place that is dry and will stay dry is the first necessity. A well balanced ration, suited to winter conditions in that it will supply, in so far as possible, something to take the place of grass and clover and "on the soil" conditions. Roots and sods are the most easily supplied substitutes. Room for exercise, and inducement to take such by scattering whole grain in the litter or feeding ear corn, are advised. The well supplied conditioner box is much more necessary during the winter than it is when the pigs are running on the land. The "under the strawstack pen or nest" succeeded because the pigs were allowed freedom of action and could therefore make a dry nest, a condition so different from that of a pig "jailed" in a pen and forced to sleep in a damp bed. Dampness is the great trouble to overcome. In the modern piggery this is accomplished by abundant glass space in the roof and walls, and elevated platform for sleeping quarters, and ventilators to carry away damp, foul air. The pig will keep itself cleaner than any other domestic animal if given freedom to do so.

Pig rations.—Grain mixtures.

Two to Three Months of Age:	Wheat Middlings	25	pounds.
	" Shorts	25	"
	Ground Oats	50	"
	Oil Cake Meal	5	"
	Meat Meal	3	"
Three to Four Months of Age:	Ground Corn or Barley	25	pounds.
	" Oats	50	"
	Wheat Shorts	50	"
	" Middlings	25	"
	Oil Cake	8	"
Four to Six Months of Age:	**Bacon Ration—**		
	Ground Corn	50	pounds.
	Wheat Shorts or Middlings	50	"
	Ground Barley	50	"
Four to Six Months of Age:	Breeder's Ration—		
	Ground Corn or Barley	50	pounds.
	" Oats	50	"
	Wheat Shorts	50	"

Corrective for Winter Use.

A trough or long box divided into five or more compartments should be placed in the pens or feed yards. Each section of the trough should be supplied with one of the following substances: Wood ashes, charcoal, salt, bone meal, and a mixture of one part sulphur, one part salt, ten parts wood ashes.

Exhibition.

Pigs presented for exhibition at school or other fairs should first of all be of the proper type and weight for the class in which it is planned to exhibit them. The exhibit should be clean. This condition is best accomplished by an application of warm water, soap and the scrubbing brush. The crate or pen should be well bedded with straw or shavings to make it comfortable and attractive. It should also be free from nails, old wire, broken bottles or any other material likely to injure the exhibit.

Causes of Failure in Feeding Young Pigs.

1. No one on hand to see that everything is right when pigs are born.
2. Excess of fat in mother's milk.
3. Cold, damp, uncomfortable quarters.
4. Intestinal parasites.
5. Shortage of sweet skim milk at weaning time.
6. Ration out of balance.
7. Ration composed of unsuitable grains.
8. Lack of mineral matter in food.
9. Housing conditions unsuitable.
10. Diseases—hog cholera, etc.
11. Neglect to alter male pigs at proper time.
12. Neglect to supply ample feed for proper development, regularly.
13. Working with poor stock.
14. Treating the pig as a general scavenger.

These pigs represent what the boys' and girls' work should look like at the end of six months. Pigs with good ancestry are always the most satisfactory feeders.

Success in Feeding Young Pigs.

1. Mother's milk normal.
2. Clean, dry, bright, comfortable quarters.
3. Practice of disease-preventive measures.
4. Ample and suitable feeds for rations.
5. Ample yard room, protection from hot sun and flies.
6. Ample clean drinking water and wallow, during hot weather.
7. Mineral matter and conditions supplied during winter when "on the soil" conditions are not available.
8. Working with well bred, vigorous stock.
9. Ample supply of green forage, such as alfalfa, red clover, sweet clover, rape and blue grass.

FEEDING OF DAIRY CALVES

Excellent calves can be reared on sweet skim milk, a product that does not differ materially from the product of the nurse cow, excepting the one material, butter fat. A comparison of whole and skim milk given in the following table shows this point quite clearly:

	Whole Milk	Skim Milk
Water	87.10	90.50
Fat	3.90	.10
Proteids	3.40	3.57
Sugar	4.75	4.95
Ash	.75	.78

The removal of the fat from the milk does not seriously reduce its value for young and growing animals, since fat in foods is used to keep be body warm and stored as a reserve for future use if supplied in excess at any period. The casein and albumen of the skim milk which is not removed by the cream separator, make the muscles and bones, and promotes the general development of the calf. Nurse cow calves are usually fatter than the sweet skim milk fed calf

A Prize Winning Jersey Calf.
Well fed and often. A kind mistress that never forgot to feed her calf.

during the first four months, but after the skim milk calf has learned to eat oats, bran and oil cake meal, it too will store up fat and cover its ribs with a fat made from the fat of the grains, and not from the expensive butter fat, as was the case with the nursed calf. Whole milk should be fed during the first three weeks, then it is well to feed half sweet skim milk and half whole milk for the second three weeks period, then changing to sweet skim milk entirely. The amount of milk to feed varies with the size of the calf, its age and development. Overfeeding or the permitting of a calf to gorge itself will generally result in indigestion. A small Jersey calf weighing under sixty pounds should not be given more than ten pounds of milk per day until it has demonstrated its ability to make proper use of more. On the other hand, a big, vigorous Holstein calf will require twice the amount to fill a somewhat larger stomach. Calves that are taken from their mothers at birth are generally much easier to teach to drink from pails. If the calf is permitted to remain with its dam for several months, and then an attempt is made to wean it, considerable loss

in patience on the part of the instructor, and fat from the calf's back, are experienced in making the change. Calves should always be fed separately, since one may drink faster than another and gorge itself to the extent of causing digestion troubles, while the slow drinker is robbed and starved. Two runts or inferior calves result. Pails should be kept clean by a daily application of boiling water. The temperature of the milk should be as near 98° as possible for young calves. Cold milk applied to a young and tender organism, such as a calf's stomach, is apt to cause serious digestion troubles. If the sweet skim milk can not be fed directly and at once from the separator, then heat should be applied to bring the temperature up to the desired degree. Calves should be taught to eat oats, bran, oil cake and pulped roots and clover hay when four weeks old. The quantities eaten will be very small at first, but these feeds should be kept before the calves in mangers that are always clean and sweet. Sour feeds and unclean surroundings are very undesirable conditions in the calf pen. After the calf has learned to eat well, which usually requires two weeks, the feeding should be regular in quantity and at definite times. Calves of the larger dairy breeds at two months of age should be taking one-half to one pound of mixed grains per day in addition to a small quantity of roots and clover. Feed whatever quantity the calves will clean up in half an hour, and do not leave feed other than clean sweet hay in their mangers from feeding time to feeding time.

Main Causes of Calf Troubles.

Cold milk to-day—warm milk to-morrow.
Sour milk to-day—sweet milk to-morrow.
Sour dirty feed pails and troughs.
Dirty pens—flies—no protection from heat or sun.
Feeding too much or too little.
No drinking water supply.
Sour whey and sour skim milk from the factory.
Vermin.

It is a good practice to leave the calf with its dam for the first two or three days, even though it is planned to rear the calf by hand.

Autumn-born calves usually escape digestion troubles, due to cold weather being an aid in preventing the souring of food.

A grass lot adjoining the stable is very useful to calves over three months of age. Young calves thrive best in a clean, well ventilated, cool, dry stable.

If the horns are not desired, treat with caustic potash before the calf is more than ten days old.

Rearing Calves Without Milk.

Good hands at calf rearing can, and do, develop good calves with very little milk. The work requires care and good judgment. Milk for the first four weeks to get the calf well started, is essential. After feeding the calf the first two weeks on whole milk, a substitute carrying many of the essential feed properties is given in a small way at the beginning and gradually increased during the second two weeks period, when it supplants the milk entirely. There are a number of very satisfactory milk substitutes on the market that are easily prepared, or others can be prepared by purchase and mixing of the following listed materials.

Wheat flour, 15 pounds; cocoanut meal, 12 pounds; nutrimen or soluble skim milk powder, 10 pounds; linseed oil meal, 5 pounds; clean dried blood, 1 pound. A suitable quantity of this milk substitute is mixed with warm water

as wanted, using one pound to each five pints of water. Two pounds per day is generally sufficient for a four-weeks-old calf. This may be increased as the calf grows, to two and a half or three pounds. Bran, oats, oil cake meal, pulped roots and clover hay should be fed liberally from the time that the calf shows a desire for such food. A clean pen and protection from heat and flies is also very essential.

Whey for Calves.

When we compare whey and skim milk from the chemical standpoint, we readily understand why poor results are obtained from the use of whey as a calf food.

	Whey	Skin Milk
Water	93.07	90.50
Fat	.34	.10
Proteids	.93	3.57
Sugar	5.00	4.95
Ash	.60	.75

The small amount of proteids in whey leaves it very short in this essential body-building material. If whey must be fed it can be made more efficient by adding to each gallon one-half pound of linseed oil meal. Whey should not be

Holstein calves that have been well cared for. No whey or ferns were used in their ration, just sweet skim milk, oats, bran and clover.

fed until the calf is at least six weeks old and has been well developed by whole milk. Sour whey from the cheese factory vat has not proven to be a good calf developer and the reason is plain. After the cheese has been taken out there is but little left to nourish anything. The whey-fed calf needs everything that the skim milk fed calf gets and more.

Calf Meals.

Calf meals prepared and sold by feed companies have not proven to be of special value. As good or better results are obtained by the use of a mixture of wheat, bran, ground oats, oil cake meal and corn meal. These common feeds can be procured anywhere for less money than the prepared calf meals sell for.

Dried Skim Milk.

This creamery product is very valuable as a calf food providing, of course, that it can be purchased in quantity and at a reasonable price. A greater effort should be put forth by creameries to dry the surplus skim milk during the flush of milk season, and thereby make this food available for the season of short feed.

Feeding of Beef Calves.

Calves of beef type or breed can be fed and developed on a part whole and skim milk ration, as described for dairy calves, providing that milk is available. The nurse cow or the dam of the calf undertaking the feeding of calf is the most popular way. This "suck the cow" system is a highly efficient way of rearing a calf, but it has one serious objection; it costs approximately twice as much per hundred pounds of gain as does the skim milk feeding. Whole milk feeding, while efficient in making gains, is the most costly system of all, in that labour must be provided to do the milking and feeding. Nurse cows that are heavy producers, may, during one lactation period, feed from two to six calves. If such cows can be procured, it is the most satisfactory way to rear beef type calves. The feeding of grain, roots, silage and clover at an early age is advised, the same as for dairy calves.

The Feeding of the Young Heifer.

Blue grass, green, succulent and in abundance, will develop the dairy or beef heifer to perfection. The chemical composition of blue grass is as follows:

Baby beef Shorthorn steer that received ample feed and kind treatment.

Water, 65.1 per cent.; ash, 2.8 per cent.; crude protein, 4.1 per cent.; crude fibre, 9.1 per cent.; nitrogen free extract, 17.6 per cent.; fat, 1.3 per cent. If we compare this analysis of biue grass with that of good corn silage, which is as follows: Water, 73.7 per cent.; ash, 1.6 per cent.; crude protein, 2.2 per cent.; crude fibre, 6.5 per cent; nitrogen free extract, 15 per cent.; fat, 0.9 per cent., it will be noted that the blue grass pasture has everything that good corn silage has and more. Native grass pastures, good silage and clover hay should be largely used in feeding the young heifers. Bulky feeds are produced on the farm, and these are just what we want to develop the digestive organs to their full working capacity. Heifers over eight months old, running on good native pastures or legume meadows, will not require any grain or supplementary feed so long as the grass remains abundant and succulent. With the decline of the pasture, other farm feed should be given in sufficient quantity to keep the animal going ahead and making a gain of at least one-half pound per day. It is a big mistake to permit dairy or beef heifers to lose weight at the close of the grazing season. The best feeders among the dairy cattle men take good care that abundant feed is at hand in

the autumn so that the heifers may winter well and keep growing. Underfeeding results in a small runty heifer that can never make up what it suffered in youth by later good feeding. Growth is peculiar to youth, and if our dairy or beef heifers are to develop into good cows, those of us who are responsible for the feed supply must provide it in a way at least liberal enough to give the animal a good chance to grow. Feeding is the principal means of promoting growth. There is no substitute and but few aids; so if you are to be progressive and have your stock up to standard, provide the feeds that make growth. Good pasture, good clover hay, good corn silage and good roots will supply abundant nourishment in desirable form. Grain feeds are expensive and need not be used other than in exceptional cases. The tables given in Section 2 of this bulletin give the nutritive values of the feeds mentioned and are intended for use in determining the most desirable ration for each and every case.

Feeding Baby Beeves.

The calves intended for the block at twelve to fifteen months of age are generally nurse cow reared, or given an opportunity to suck their dams for three

Line up at a School Fair.

months or more. Very capable feeders can rear very good beef calves with sweet skim milk, providing the calf has been given a good start on whole milk. Calves intended for the baby beef trade must be kept going from the start and not exposed to any hardship that would in any way influence or hinder a constant gain in flesh. The feeding of grain and roughage should start as soon as the calf will take such. A mixture of ground corn, 70 pounds, wheat bran, 20 pounds, oil cake, 10 pounds, fed in conjunction with pulped roots and clover to supplement the milk until weaning time is good practice. If the calves are to be finished under twelve months, the milk feeding must be liberal, for the first half of the feeding period. Calves well raised on sweet skim milk will not be as fat as those that are permitted to suck their dams or nurse cows, so must take a longer time to finish, usually fifteen or sixteen months. The milk flesh must not be lost, but added to each day, by steady, consistent gains. Clover and alfalfa hay, good corn silage and roots should form the coarse feeds; these can only be fed in moderate quantity. Since rapid gains are necessary, the feed must be rich, in that a large percentage of grain is used in the ration. Well

grown calves, six months old, will take from five to six pounds of corn meal, two pounds of bran, and one-half pound of linseed oil meal per day. This should be increased gradually as the calf can be induced to take more. It is very essential that laxative feeds like roots and silage should be fed. Without laxative feeds in the ration, digestive troubles are apt to result from heavy grain feeding. Clean, sweet feeds, clean mangers and pens, plenty of clean water and kind treatment are very necessary. The heavy milk and grain feeding makes the rearing of baby beef the business of a specialist, and poor feeders can not expect to succeed. The tables given in Section 11, in which values of various feeds are given, should be consulted and a ration figured to suit your own special case. (See Section 2 for feed tables.)

Exhibiting.

Calves that have been fed liberally and judiciously will have developed, as the factors which we call heredity, determine. It will be all calf, but its perfection of form is determined by its parentage. Feed cannot make a square beef calf out of a three-cornered dairy calf. So to begin with, the feeder should select the young calf largely on the individuality of the parents. Get a calf that will feed out to be as good or better than its ancestors—something that is worth while spending time and money on—and then take care of it. The breed score cards give clearly what is desired in breed type. These should be studied along with the animal that is being selected for exhibition. Calves should be halter-broken when young and handled gently, that they may be quiet and docile at exhibition time. If in proper flesh to look well, ribs and back well covered, it is comparatively easy to complete the work of preparation. Prospective exhibits should be kept in the stable for several weeks previous to the fair, where they can be washed, groomed and blanketed, in order that their handling qualities may reach a degree of mellowness that is very desirable in exhibition calves. When exhibiting before the judge see that your calf is standing on level ground, quietly and with feet well placed, so as to present a good appearance. Don't let the other exhibitors crowd too closely, and hide your exhibit from view.

FEEDING THE FARM COLT.

The general practice in rearing colts is to permit the foal to run with its mother and nurse whenever it has the inclination to do so. This practice, while approved by all, frequently does not do everything possible for the colt, whose main business is to grow. Brood mares frequently do not produce sufficient milk to properly and fully nourish the foal. This condition may be due to the mare being a poor producer or to her owner being a poor horseman and feeder. The young colt should be fed through its mother if possible. If the mare can be induced to produce all the milk that the foal can take, no other feeding is required during the first ten weeks. On farms where the mares are not required to work on the land while nursing a foal, the feeding must be liberal and of such a nature that it will nourish the mare and provide for the production of the required amount of milk. Good grass will provide such. If the foal is born early in the season before the grass comes, the mare should be fed a grain mixture, consisting of four parts ground oats, four parts wheat bran and one part oil cake meal. With the grain ration, clean bright hay, preferably clover or alfalfa, and a few roots should be given.

Supplementary feeding for the foal should start as soon as the youngster can be induced to eat. This is soon learned if the mother is feeding in a box

stall where there is room for the colt to get to the manger. Colts that have not been getting sufficient milk for their best development should be taught to drink cow's milk. This should be given fresh from the cow and in quantity limited by the needs of the individual. Two quarts or more, twice or three times a day, will do very much for a foal that is being undernourished by its dam. Milk feeding is frequently practised with colts of the draft breeds when it is desired to force their growth as much as possible. Colts learn to take milk quickly and there is little danger of them drinking too much. To do its best the colt should be given in small and frequent feedings nearly all of a well balanced grain feed that it will take. The following grain mixture has proven satisfactory: Ground oats, wheat bran and corn, each three parts; oil cake meal, one part. When colts are running in the pasture field with their mothers, it is frequently desirable to arrange a feed trough that can be reached by the colts but not by the older horses. Either good grazing or the best quality hay should be supplied liberally during the season and every effort made to insure the colt's comfort and contentment. When the mother of a young foal is required to do a share of the farm work, such task should not be forced on her until she has had at least two weeks' rest following the birth of the foal. Light work only should be given until the mare becomes hardened. The foal should be kept in the stable while the mare is at work. A large, light box stall that is free from obstructions on which a foal might injure itself, and in which a feed manger and water pail can be placed at convenient height, should be used. The foal should not be permitted to nurse if its mother is overheated. It is better to milk the mare out and keep her away from the foal until such time as she is cooled off. Signs of thrift are unmistakable in the colt, and if not present, the feeding or nutrition is generally the cause of its absence. If colts are not given every opportunity to grow, that feed and care can supply during the first twelve months, no amount of care or feed given during the second or third year can make up for the neglect suffered by the colt during its first year. Good draft horse men aim to make the colt weigh at the end of the first twelve months, half the weight of the matured horse. To do this, something more than ordinary pasture field or barn-yard care is very necessary. Foals that are well fed during the period when nursing, are easily weaned at five months of age. The hay and grain ration should not stop with weaning, but should be increased to suit the demand of the colt. The colt should be allowed the freedom of a large box stall, with paddock adjoining, where ample exercise can be taken. Two foals running and feeding together is a better arrangement than one running alone. The box stall or pen should be light, dry, well bedded, clean and warm. Oats, and wheat bran in the proportion of four pounds of ground oats to one pound of bran, is the best dry grain ration for colts ranging in ages from six to eighteen months. Boiled mixed grains and cut alfalfa or clover are frequently used by good horsemen for the night feed to colts each day during the winter period. Corn, barley and oats are used in equal proportions when boiled grains are used. These are boiled each day and fed warm, not hot. A small quantity of carrots can be used to advantage in feeding colts during the winter period. All feeds should be clean and free from dust. The drinking water should be pure and always available. Colts should be kept growing and fat; the liberal feeding of grain during the period of short pasture and winter time is the only way to do so. Thin colts can never reach the maximum weight. Good pasture will generally carry the colts along the second summer during the flush of grass, but if full development is sought, supplementary feeding with grain must be practised. Good clean oats, wheat bran, alfalfa or mixed hay, if given in quantity

to satisfy the appetite of the colt will take care of the nutrition needs, when the colt is weaned and off the grass. Careful work on the part of the feeder in looking after the body comfort and necessary exercise will do the rest. Foals that have lost their mothers can be successfully reared on cow's milk. Bottle feeding or drinking from a tea pot spout or pan is soon learned. Small, frequent feedings should be given, and great care exercised in having the milk and feeding utensils fresh, clean and sweet. The foal, when with its dam, will nurse at intervals not more than two hours apart, so the hand feeding should be the same in frequency. When the foal is four weeks old it should be encouraged to eat oatmeal, wheat bran and a little oil cake meal. The milk feeding can be continued up to eight or ten months, if desired. Liberal and careful feeding, together with good management by a person of sympathetic nature, will save a motherless foal. When the foal is five months old, it can be carried on as described for the normal foal. Consult Feeding Standards in Section 2, for feed tables.

Well fed, well broken to halter, well groomed, a pleasure to handle, and a colt to be proud of.

As an aid to feeding colts the following points should be observed:

1. Halter break and handle the colt quietly and kindly.
2. See that the colt has ample exercise and has company.
3. Provide comfortable shelter from cold and storm in winter, and from heat and flies during the summer.
4. Keep the mare's feet in shape, level and toes short.
5. If the mare's milk is too rich or otherwise not normal, the colt cannot thrive.
6. Watch for internal parasites, also external parasites.
7. Keep the colt's skin and hair clean by using the brush.
8. Do not expose the colt to diseases such as distemper, etc.
9. Watch the development of the colt's teeth; if not normal, have veterinary dentist examine them.
10. If you are expecting the arrival of a foal, prepare the stall or paddock so that the risks incident to birth and navel infection thereafter, are reduced as much as possible. Have everything clean.

11. Wean the colt when five months old, keeping it out of sight and hearing of its mother.

12. Do not expose colts to the dangers of fences out of repair, barb-wire, broken bar-ways and gates.

13. Do not use mouldy or frozen feeds.

14. Do not feed more at any one time than the colts will eat up quickly.

15. Clean, fresh water should be available at all times.

16. Use horse sense when dealing with the colt; treat it as you would like to be treated.

17. Let the foal's mother do all she can in nourishing and protecting her progeny, but remember that you, as a man, are responsible for both the mare and the foal, and that the mare cannot do very much if she has not your sympathetic aid.

Exhibiting.

The colt selected for competition at the fair should meet the requirements of the class in which it is planned to exhibit. It should also be typical of the

These colts are standing quietly, but the halters indicate that the early education of the colts was neglected.

breed that it represents. As with the calf, the colt can only be what its ancestors make it. Colts may look very much alike when only a day old, but they certainly do not develop alike, even if the care and feed are the same. So get your start by selecting your exhibition prospect from good type parentage, exhibition stock, if you can. Liberal feeding from the beginning on a comparatively narrow ration, to develop all the bone and muscle possible, should be the aim. Halter breaking and careful schooling, to develop courage and tractability, should be practised from the beginning. The colt's feet should be trimmed frequently enough to keep them in proper shape. Teaching the colt to move attractively at the walk and trot, to stand well and to permit handling of its feet is very essential in the general training of the colt. Such training is also a great aid on exhibition day. The colt that has had liberal treatment from birth, and developed well, needs but little exhibition fitting. Good feeding will put a bloom on the colt that cannot be attained in any other way. Protection from the hot sun and flies, blanketing and grooming are material aids in developing

a desirable coat condition and should be practised during the month previous to the exhibition. Ribbon and straw decorations, while very attractive to the average good horseman, do not carry very much weight with the high class judge, and are not likely to be of influence, except in very close competition. The practice is desirable, not so much for what it may do to the colt, but for what it indicates in the boy.

FEED REQUIREMENT OF YOUNG ANIMALS

The Balanced Ration.

The most essential food for all young animals is milk. It is generally accepted as a balanced ration for the young of all classes of domestic live stock. During the first four weeks of the young animal's life, little heed may be given to the ration being in proper proportion or balance, providing, of course, that the young is supplied with milk from its dam.

COMPOSITION OF MILK FROM VARIOUS DOMESTIC ANIMALS

Animal	Water	Ash	Protein	Fat	Carbohydrates
Cow	87.1	0.7	3.2	3.9	5.1
Mare	89.8	0.3	1.84	1.17	6.89
Sow	84.04	1.05	7.23	4.55	3.13
Ewe	79.46	.97	6.68	8.63	4.28

With whole milk as the only food given to colts, calves, pigs and lambs during the first four or six weeks, it will be noted that the nutritive ratio of the milk from the various sources differs. The nutrition of the young animal, therefore, also is subjected to severe deflections, if the milk of one class of animals is used to feed the young of other classes during the first two or three weeks.

Average	cow's	milk	testing	3.9 %	of fat	has a	nutritive	ratio 1:4.3
"	mare's	"	"	1.17%	"	"	"	" 1:6.2
"	sow's	"	"	4.55%	"	"	"	" 1:1.8
"	ewe's	"	"	8.63%	"	"	"	" 1:3.5

The carbohydrate content of milk is in the form of milk sugar, easily soluble and digestible. The fat content is commonly known as butter fat, which is made up largely of the glyceral salts of fatty acids, all of which are easily digested by the young animal. Some judgment is required in substituting the milk of cows in feeding orphan lambs, colts or pigs. The fat and protein content varies greatly. Of these two, the fat content of the milk is the most important during the first two weeks, which is the most critical period in the youngster's life. The removal of part of the fat or the addition of milk sugar, or the addition of more fat in the form of sweet cream, is suggested, so as to bring the substituted milk up to the normal of the class of animal that it is desired to feed. For instance, cow's milk can be improved for the foal by removing a portion of the fat and adding milk sugar, for the lamb by increasing the fat by adding cream or using the milk from very high testing cows; for little pigs by adding egg albumin to the milk of high testing cows. After the first two weeks, the digestive systems of the orphan young can handle normal cow's milk very well, and the additions or subtractions recommended can be dropped.

The nutritive ratio, or balance between the digestible protein and digestible carbo-hydrate content of the feeds forming the ration is, if correct, compara-

tively narrow during the early life and widens as the animal grows older. During the first three months, calves, lambs and pigs are best carried on a ration not wider than 1.4, colts 1.6, these ratios being widened gradually to suit the animal's needs. For instance, a six-months-old pig, weighing 150 to 200 pounds, would be fed on a ration with a ratio 1:6.5, a fattening lamb, 50 to 75 pounds in weight would be best suited with a ration with a ratio of 1:5.5, a twelve-months-old calf, for beef or dairy, would make the best gains on a ration as narrow as 1:4.5 up to a body weight of 250 pounds, with a gradual widening to 1:6.5 by the time 500 to 1,000 pounds in weight had been attained. The growing colt, over six months of age, can be developed most successfully on a ration having a nutritive ratio of 1:7.

To calculate the requirement of any animal consult the tables in Section II, under the headings, "Feeding Standards and Digestible Nutrients." Find the requirement of the animal and the suggested ratio, using the Composition and Digestible Nutrients table; figure out trial rations, using the feeds that you have on hand, in so far as possible.

Sample Trial Ration for Colts.

To calculate the requirement of a growing draft colt weighing 1,000 pounds:

Trial Ration	Total Dry Substance	Digestible Crude Protein	Digestible Carbohydrates	Digestible Fat
Oats—8 pounds	7.12	.73	4.13	.34
Corn—2 "	1.78	.15	1.35	.09
Bran—2 "	1.80	.25	.83	.06
Alfalfa Hay—10 pounds	9.09	1.04	3.80	.07
Oat Straw—5 pounds	4.54	.06	1.93	.04
	34.33	2.23	12.04	.60

The Digestible Carbohydrates plus (Digestible Fat multiplied by 2.25) divided by Digestible Crude Protein is the formula commonly used in determining the nutritive ratio.

$$\frac{12.04+(.60\times 2.25)}{2.23}=\frac{13.39}{2.23}=6.$$

The nutritive ratio is in this instance 1 to 6.

This ration could be widened by reducing the amount of oats and increasing the corn, or by using timothy hay instead of alfalfa.

SAMPLE TRIAL RATION FOR DAIRY HEIFERS
500 Pounds in Weight

The standard calls for 13.5 pounds dry substance, 1 pound digestible protein and 6.5 pounds total digestive nutrients.

Trial Ration	Total Dry Substance	Digestible Crude Protein	Digestible Carbohy-hydrates	Digestible Fat
Corn Silage—20 pounds.....	5.26	.22	2.98	.14
Alfalfa Hay — 5 "	4.95	.52	1.90	.035
Ground Oats— 2 "	1.78	.18	1.38	.08
Oat Straw — 2 "	1.80	.028	.78	.016
	13.79	.948	7.04	.271

Nutritive Ratio

$$\frac{7.04 + (.271 \times 2.25)}{.948} = \frac{7.64}{.948} = 1:8$$

This ration is too wide and could be improved by adding more alfalfa and reducing the silage and oat straw.

SECTION II

FEEDING STANDARDS

Per day, per 1,000 pounds live weight

Animal	Dry Substance	Digestible Crude Protein	Total Digestible Nutrients	Nutritive Ratio
	lbs.	lbs.	lbs.	1:
Growing Colt.....	18.0 - 22.0	1.6 - 1.8	11.0 - 13.0	6.0 - 7.0
Brood Mare, Suckling Foal...	15.0 - 22.0	1.2 - 1.5	9.0 - 12.0	6.5 - 7.5
Dairy Heifer, 150 lbs.....	23	4	15	4.5
300 "	24	3	13.8	5.1
500 "	27	2	13	6.8
700 "	26	1.8	12.9	7.5
900 "	26	1.5	12.3	8.5
Brood Sow.....	20.0 - 24.0	2.4 - 2.7	18.0 - 21.0	6.0 - 7.0
Young Pigs— 50 lbs.....	46.2 - 51.0	7.8 - 8.5	41.0 - 45.4	4.0 - 4.5
100 "	37.0 - 40.8	5.5 - 6.0	32.9 - 36.4	5.0 - 5.6
150 "	32.4 - 35.8	4.4 - 4.9	28.8 - 31.9	5.5 - 6.2
200 "	29.0 - 32.0	3.5 - 3.9	25.8 - 28.5	6.2 - 7.0
Lambs—50 lbs.....	27.0 - 30.0	3.1 - 3.3	19.0 - 22.0	5.0 - 6.0
90 "	28.0 - 31.0	2.5 - 2.8	20.0 - 23.0	6.7 - 7.2
100 "	27.0 - 31.0	2.3 - 2.5	19.0 - 23.0	7.0 - 8.0
Ewes with Lambs.....	23.0 - 27.0	2.6 - 2.9	18.0 - 20.0	5.6 - 6.5

NOTE:—The above figures taken from Henry and Morrison and Wolff Lehmann Feeding Standards.

FOR HORSES, CATTLE, SHEEP AND SWINE.

Total Dry Substance and Digestible Nutrients in 100 Pounds of Average Good Quality Feeds.

Horses, Cattle and Sheep	Total Dry Substance	Crude Protein	Digestible Carbo-hydrates	Digestible Fat
Corn	89.4	7.6	67.5	4.6
Corn Meal	88.2	7.3	67.7	3.8
Wheat	89.5	8.8	68.0	1.5
Rye	89.	8.9	68.3	1.1
Oats	89.	9.2	51.7	4.3
Barley	88.	8.9	64.5	1.4
Buckwheat	87.4	7.5	51.1	2.2
Field Peas	89.5	16.8	55.8	.6
Flax Seed	90.8	20.6	17.1	29.0
Sunflower Seed	91.4	11.1	33.4	18.4
Corn Bran	91.3	5.9	58.1	5.0
Wheat Bran	90.0	12.6	41.5	3.0
Oat Bran	93.4	9.8	53.3	4.4
Oat Hulls	92.7	1.7	45.4	.8
Cottonseed Meal, Good	92.8	31.7	27.0	7.1
" " Choice	93.	37.5	21.3	9.5
Linseed Meal, O.P	91.5	30.5	33.2	6.3
" " N.P	91.	32.2	38.2	2.6
Beet Pulp, dry	90.	4.7	63.8	.5
Beet Molasses	79.2	2.9	53.6	..
Cow's Milk, whole	12.8	3.6	4.9	3.7
" " skim	9.5	3.6	5.1	.1
Buttermilk	9.6	3.6	5.0	.2
Whey	6.2	.6	5.1	.1
Alfalfa Hay	90.9	10.4	38.0	.7
Alfalfa Leaves	93.2	15.8	35.1	1.3
Alsike Clover Hay	85.0	9.2	35.4	.8
Red Clover Hay	85.0	7.7	37.3	1.4
Sweet Clover Hay	90.3	11.5	42.2	1.5
Field Pea Hay	85.0	9.3	37.3	.9
Vetch Hay	86.8	12.9	39.0	1.5
Timothy Hay	86.8	2.8	42.4	1.2
Oat Hay	86.6	4.2	38.1	1.8
Rye Hay	92.0	3.7	42.4	1.2
Corn Fodder	81.7	3.0	48.7	1.3
Sorghum Fodder	91.1	2.1	48.1	1.8
Oat Straw	90.8	1.2	38.7	.8
Corn Silage	26.3	1.1	14.9	.7
Clover Silage	28.0	1.3	9.4	.5
Carrots	11.4	1.0	8.7	.4
Mangel	8.8	.7	5.3	.1
Potato	21.1	1.3	15.6	..
Turnip	9.4	.9	6.0	.1

Swine	Total Dry Substance	Digestible Crude Protein	Digestible Carbo-hydrates	Digestible Fat
Corn, shelled	89.4	7.7	65.8	3.2
Corn Meal	88.2	7.4	66.7	2.6
Wheat	89.5	9.5	60.8	1.5
Barley	88.0	8.8	60.	.8
Rye	88.4	8.9	68.3	.7
Wheat Bran	90.0	12.1	39.1	3.2
Wheat Shorts	90.0	14.8	50.2	4.2
Wheat Middlings	90.0	15.0	49.4	4.1
Pea Meal	89.5	18.2	59.4	.5
Linseed Meal	91.5	29.2	31.2	5.0
Skim Milk	9.5	3.6	5.1	.1
Buttermilk	9.6	3.6	5.0	.2
Dried Blood	91.5	60.8	.....	2.0
Tankage	93.0	43.3	....	10.0
Potato	21.1	1.8	17.3	....

Swine do not digest feeds with the same thoroughness as do the ruminants, hence it is necessary to use the above table when calculating rations for swine.

MINERAL MATTER.

Percentages of Mineral Matter in the Different Classes of Feeding Stuffs.

Milk and milk products	.4 to .8	Straws	3.2 " 5.8
Roots	.8 " 1.2	Stovers and fodders	3.7 "12.0
Silage	1.1 " 2.8	Cereal by-products	1.0 " 6.2
Grass pastures	1.0 " 2.8	Oil "	4.0 " 6.7
Cereal grains	1.4 " 3.0	Grass hays	3.9 " 7.9
Leguminous pastures	1.3 " 3.5	Leguminous hays	6.7 "10.7
Leguminous seeds	2.6 " 5.4	Packinghouse by-products	4.1 "64.4
Oil-bearing seeds	2.6 " 4.3		

The ash consists principally of the mineral elements, potassium, calcium, magnesium, iron and sodium, in the form of oxides, phosphates, sulphates, cabonates, and chlorides.

Calcium.—Especially abundant in bone meal, tankage and leguminous hays, while the ordinary grains and many of their by-products are deficient. Very essential to young growing animals and dairy cows, apt to be deficient in many feeds.

Magnesium.—Most abundant in the oil products and in wheat bran. Straws and roots are low in this element.

Phosphorus.—Most abundant in bone meals, tankage, bran middlings, oil seed by-products and legume seeds. Grain and legume hays contain medium amounts of this element. Very essential to young growing animals and the dairy cow. Apt to be deficient in many feeds.

Iron and Sulphur.—Present in small but sufficient quantity in all feeds.

Sodium and Chlorine.—Usually deficient and must be supplied. Mineral matter used for the formation and repair of the bones, the protein tissues and the body fluids, such as blood, milk and the digestive fluids, also used to maintain the neutrality, alkalinity or acidity.

AVERAGE COMPOSITION OF MEAT-PRODUCING ANIMALS.

Animal	Condition	Water %	Protein %	Fat %	Ash %
Calf	At birth	72.1	19.5	4.8	3.9
" —Good	500 pounds	62.9	19.2	13.7	4.2
Steer "	1,000 "	53.	17.6	25.5	3.8
" "	1,500 "	43.5	15.7	37.7	3.2
"	Very thin	69.2	21.0	2.2	7.0
"	Thin	60.1	19.3	14.4	5.4
"	Half fat	56.4	17.6	19.1	4.8
Sheep	Thin	57.3	14.8	18.7	3.2
"	Half fat	50.2	14.0	23.5	3.2
"	Fat	43.2	12.2	35.6	2.8
"	Very fat	35.2	10.9	45.8	2.9
Pig	4 mos. thin	61.7	15.5	19.0	3.2
Hog	Thin	59.5	14.9	20.5	3.0
Hog	Fat	45.0	13.8	38.0	3.5

Water.—New born calves, 72 per cent; very fat sheep, 35 per cent. The blood, 3 to 10 per cent. of body weight, is 80 per cent. water. The tissues, excluding the fatty tissues and bones, contain 50 to 85 per cent. water. The skeleton contains from 30 to 60 per cent. water. In general, more than half the weight of our farm animals is water. The fatter the animal, the smaller the percentage of water which it contains.

Mineral Matter or Ash.—Farm animals usually contain 3 to 5 per cent. mineral matter, principally in the bones, protein tissue and body fluids.

Calcium.—Most abundant constituent, found especially in the bones as a phosphate.

Phosphorus.—Found in the active tissues and body fluids.

Potassium.—Found in the lean tissues, as muscles, organs, blood.

Magnesium.—Found distributed throughout the body.

Sodium.—Found in the body fluids.

AVERAGE WEIGHTS OF CONCENTRATED FEEDS.

Name of Feed	One Quart Weighs	One Pound Measures
	Pounds	Quarts
Alfalfa meal	.6	1.7
Beet pulp—dried	.6	1.7
Barley meal	1.5	.7
Corn—whole	1.7	.6
Corn meal	1.5	.7
Cottonseed meal	1.5	.7
Gluten meal	1.7	.6
Linseed meal—Old process	1.1	.9
" new "	.9	1.1
Molasses	3.	0.3
Oats—whole	1.	1.
" ground	.7	1.4
Rye—whole	1.7	.6
" meal	1.5	.7
Soy beans	1.8	.6
Wheat—whole	2.	.5
" ground	1.7	.5
" bran	1.7	.5
" bran	.5	2.
" middlings (standard)	.8	1.3
" " (white)	1.2	0.8
Skim milk	2.	.5

Hay, well settled, Alfalfa, 512 cubic feet per ton.
Clover, 450 " "
Timothy 450 " "

Silage out of silo weighs approx.	40	pounds per bushel				
" in the silo "	18.7	"	" cubic foot at surface.			
" " "	33.1	"	"	"	10 feet from surface.	
" " "	46.2	"	"	"	20	" "
" " "	56.4	"	"	"	30	" "

ACKNOWLEDGMENTS.

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

GRAFTING FRUIT TREES

By JAS. A. NEILSON, B.S.A., M.S.

Grafting is an old and very useful horticultural practice. History does not definitely record when the practice originated, but it is known that it was followed by Roman horticulturists four hundred years before the Christian era. Since the discovery of the art it has been extensively developed, and is now used in all countries where fruit trees are grown.

Grafting may be defined as an operation in which a twig or a piece of bark containing one or more living buds is cut from one plant and inserted in a cleft or incision made in a piece of root, or the stem or branch of another plant, in such a way as to insure a continuation of growth.

Baltet, a French writer, in his book on grafting, mentions forty-seven methods of grafting in use by expert horticulturists in France. The present bulletin, however, is not intended as a complete treatise on grafting, and therefore only those methods which are of greatest value to the Ontario fruit grower will be discussed. The methods described herein are as follows: Cleft Grafting, Bark Grafting, Whip Grafting, Strap Grafting, Notch Grafting, Bridge Grafting, and Bud Grafting or Budding, as it is generally called.

Meaning of Terms Used in Grafting

1. Stock: The portion of root, stem or branch on which the scions or buds are placed.
2. Scion: A section of a one-year-old branch containing one or more living buds. The part which is inserted on the stock.
3. Cambium layer: A thin layer of soft greenish coloured tissue situated between the bark and the wood. It is the growing part of the tree.
4. Bud-stick: A small branch of the current season's growth from which the buds are cut.
5. Bud: A living bud cut from a bud-stick.
6. Raffia: A strong pliable tying material used to hold the buds in place on the stock. It is the best material for the purpose and is carried in stock by seedsmen and florists.

Objects in Grafting

Grafting may be used: (1) to renovate or top-work a tree; (2) to repair injury to trunks or branches; (3) to propagate varieties.

(1) RENOVATION OR TOP WORKING

The renovation of fruit trees is often desirable and may be accomplished by different methods of grafting such as Cleft Grafting, Bark Grafting, Strap Grafting, Whip Grafting, Notch Grafting and Budding. Top-working is the term generally used to designate this process which is made use of for the following purposes:

1. To Improve the Quality and Size of Fruit

Varieties (or seedlings) which are undesirable because of small size or poor quality of fruit may be changed over and made to bear fruit of larger size and good quality by top-working with any variety possessing these characteristics.

2. To Secure Earlier Fruiting

Certain varieties which take a long time to come into bearing may sometimes be brought into bearing earlier by top-working them on early maturing, less vigorous varieties. Grafting some varieties of the pear on the quince stock is known to hasten the production of fruit.

3. To Obtain Greater Disease Resistance

Fruit trees—the cultivated pear for instance—are subject to a very destructive disease, bacterial blight. It has recently been found that pears may be made more blight resistant by growing blight resistant stocks such as *Pyrus Ussuriensis* or *Pyrus Calleryana* and top-working these with good commercial varieties.

4. To Secure Greater Hardiness

Varieties which when grown upon their own trunks are subject to forms of winter injury such as collar rot, sunscald, or crotch injury, may be grown successfully by top-working on hardy varieties planted for the purpose. The King top-grafted on the Tolman Sweet, or the Grimes on Virginia Crab or Hibernal, are examples of the use of grafting as a factor in growing semi-hardy varieties on hardy stocks.

5. To Correct Pollination Difficulties

Some varieties of plums and sweet cherries when grown in a solid block fail to set fruit owing to imperfect pollination. This difficulty can be overcome by grafting a few trees or a few branches with scions of varieties useful as pollenators.

Adaptation of Various Methods to Different Kinds of Fruit Trees

Apple, Pear, Plum, Sweet and Sour Cherry trees may be readily top-worked by any of the methods previously mentioned except bridge grafting. The method used will, of course, vary with the size of the trees; Peach and Apricot trees, however, cannot be top-worked very satisfactorily by these methods, but can be quite easily top-worked by budding.

When Grafting May be Done

The time for grafting will depend upon the methods to be used. Cleft, Notch and Whip Grafting should be performed just before growth starts in the spring; but Bark, Strap and Bridge Grafting are best done a little later when the sap is flowing freely. If the scions are in a dormant condition, Bridge Grafting may be done even when the trees are in bloom. Budding is usually done in July or August when the sap is flowing freely and the bark will slip easily.

Fundamental Conditions to be Observed in Grafting

1. The stock and the scion must be closely related in order to facilitate those physiological processes of growth which are necessary for a union.
2. The cambium of the stock and that of the scion must be brought closely into contact at some point. The greater the area of contact of these layers of tissue the more certainty there is that a union will be formed.
3. All clefts or incisions must be properly covered with wax or other equally good material after the scions or buds have been inserted. This is necessary to prevent the loss of moisture and the entrance of decay or disease-producing organisms.
4. The operation must be performed at a time suitable to the style of grafting used.
5. Careful, accurate work is necessary in cutting and fitting the scions or buds to the stock.
6. The scions or buds and the stock must be in a healthy condition.
7. The stock and the scion should grow at about the same rate.

Selection of Scions

Scions are made from well ripened wood of the previous season's growth, and should preferably be cut from the outer, upper branches of healthy, heavy bearing trees of the desired variety. Scions taken from such trees will, in all probability, give more satisfactory results than scions selected without any regard to the bearing habits of the tree from which they were taken.

Scion wood may be taken any time from late autumn until the sap begins to flow in the spring, but the best results will likely be obtained from scions taken late in the autumn or early winter after the wood has become well ripened. If taken before cold weather sets in there is no risk of having the scion wood injured by very low temperatures which frequently prevail in the latter part of the winter. Scion wood taken in the autumn or early winter should be placed in boxes in damp sand, leaves, moss, or sawdust and stored in a cool cellar until required in the spring. If the scions are not taken until spring they should be cut before growth starts and stored until wanted for grafting.

Selection of Branches for Grafting

Branches ranging from 1 to 3 inches in diameter are satisfactory for cleft, bark, notch, and strap grafting, but for whip grafting branches of ¼ to ½ inch in diameter are best. If small trees are to be top-worked by budding, branches from ¼ to 1½ inch in diameter may be used, but the smaller size is usually the more satisfactory. Avoid choosing branches for budding or grafting which are close to or immediately under other desirable branches.

Where it is desirable to top-work large trees, the operation should be spread over a period of two or three years. From one-third to one-half of the branches (preferably the main leader and upper branches) should be grafted the first year and the remainder during the next year or the following year. If a large tree is grafted all at once the shock from the operation will be great, a large number of shoots will likely develop, which will hinder the proper growth of the scions and entail considerable labour to remove. Whip grafting and budding are usually confined to small sized trees and may be completed at one operation.

Branches selected for cleft, bark, notch or strap grafting should be cut off quite near the central axis of the tree, the distance from the centre depend-

ing on the size of the branch. On small trees the cut may be made 8 to 12 inches from the centre, but on large trees the cut should be farther from the centre owing to the larger size of the branch. If possible the cut should be made not farther out than four feet, but this, however, cannot always be done because of the large size of the branch. In all cases one should endeavour to select branches which will make a strong, well-built, shapely tree with a moderately low head. In cutting long or heavy branches care should be taken to prevent splitting. This can be done by cutting, first, on the under side of the branch and then cutting from the top or by supporting the branch beyond the point where it is to be cut; or the branch may be cut off a short distance beyond the place where the scions are to be inserted and the short stub which remains can be cut at the proper place without any danger of splitting. On trees which are not too large for grafting all at once, one should, where possible, cut the branches just beyond a lateral so that the lateral will partly absorb the flow of sap and thus prevent the scion from being injured by a too abundant sap supply.

Cleft Grafting

Cleft grafting is one of the best known methods of top-working trees. In this method the branches selected for grafting are cut squarely across at the point where it is desired to place the scions; the end of the branch is then split with a grafting knife to form a cleft for holding the scions. When an upright growing branch (or trunk of a tree) is to be cleft grafted, the cleft may be in any direction, but branches which grow out at an angle should be split horizontally, and not vertically as is sometimes done. The reason for this is that if the branches were split vertically and two scions were inserted one would of necessity be placed at the top of the cleft and the other would be at the bottom. In this instance the lower scion would not have equal chance with the upper one and might not grow well; but if both were placed in a horizontal cleft each would have the same conditions and both would be more likely to grow. The clefts should not be deeper than is necessary to hold the scions properly. Deep clefts do not hold the scions so firmly as shallower clefts and take longer to heal. A cleft two inches deep would be quite sufficient in most cases but, of course, it is not always possible in practice to prevent the branches from splitting deeper than is necessary to merely hold the wedge end of the scion. After the branch has been split the wedge-shaped portion of the grafting knife is inserted in the centre of the cleft to hold it open for the reception of the scions.

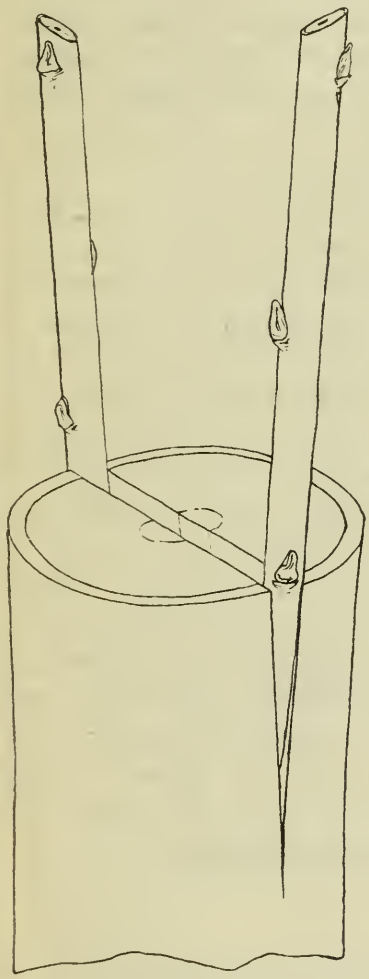
The scions should be prepared for grafting immediately before they are to be placed on the stock. The method of preparation varies with the type of grafting used. For both cleft and bark grafting the scions are usually about four inches long and should contain from two to four buds.

Scions for cleft grafting are prepared by making a straight sloping cut about one to one-and-a-half inches long on one side of the lower end of the scion and then making a similar cut on the other side, thus forming a long thin wedge. One side of this wedge should be slightly thicker than the other and should be made so that a bud is left just above the top and on the thicker side of the wedge.

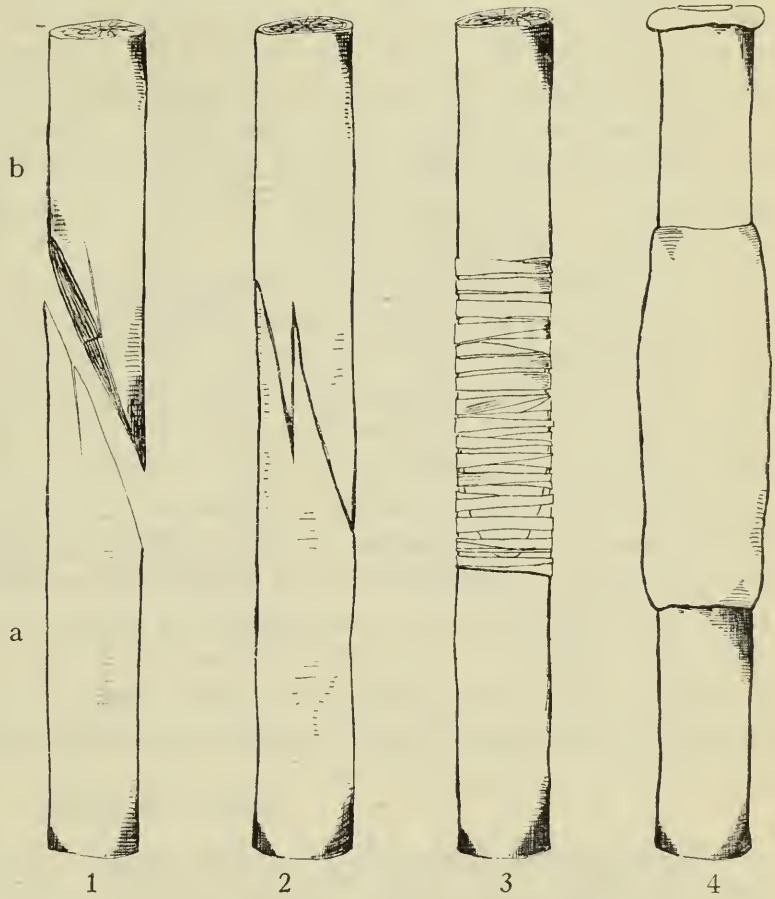
The wedge end of the scion is then inserted in the end of the cleft in such a position that the bark of the scion crosses the bark of the stock, and the top of the wedge part of the scion is on a level with the end of the branch with the thick side outward. To make sure that the cambium layer of the scion comes in

contact with the cambium layer of the stock the scion is inserted at a slight outward angle to the general direction of the branch.

When the scions have been placed, the wedge of the grafting knife is withdrawn, thus allowing the branch to close on the scions and hold them firmly in position. If a large limb is to be cleft grafted a small hardwood wedge should be inserted in the centre of the cleft to prevent the stock from closing too tightly on the scion and thus interfering with a proper union. The cleft in the end and on the sides of the branch is then filled with grafting wax and the end of the



Cleft Grafting
Stock branch with scions in position.



Whip Grafting
1—(a) Stock; (b) Scion. 2—Stock and scion fitted together. 3—Tied with raffia or grafting twine. 4—Waxed.

branch is coated with the same material to prevent drying and to exclude disease organisms. Branches one inch in diameter require only one scion, those over one inch in diameter will require two. Large branches, for example those of 4 to 5 inches in diameter are sometimes cleft twice, the two clefts being on opposite sides, or in some cases, the branch is cross cleft. Double clefting and cross clefting are not recommended, as such branches can be more satisfactorily worked by bark grafting.

Whip Grafting

Whip grafting is employed to a considerable extent as a means of top-working small trees. In this method it is desirable to have the stock and the scion of the same, or nearly the same, size and, therefore, stocks ranging from one-quarter to one-half inch in diameter are the best for this purpose. One-year-old trees may be trunk grafted, but in the case of two or three-year-old trees the scions should be placed on the small branches near the main fork. The stock is prepared for the scion by making a long, straight, smooth cut diagonally across the trunk or branch. The length of the cut will vary from one to two inches, depending on the size of the trunk or branch. A tongue from one-half to three-quarters of an inch deep is then made on the face of this sloping surface by inserting the knife just above the heart and cutting diagonally across the heart. By cutting diagonally across the heart there is less danger of splitting the stock than is the case where the cut is made in the direction of the grain. The scion is prepared in precisely the same way and should contain three or four buds, one bud being just above the top of the sloping cut. The scion is then fitted to the stock by inserting the tongue of the scion into the cleft of the stock. If the stock and scion are the same size the cambium layers will necessarily come into contact on both sides, but if the stock and the scion are not exactly the same size then the cambium layers must be brought into contact on one side or the other. When the scion has been fitted to the stock the two are firmly tied together with bast, raffia or waxed string, special care being taken to have the greatest possible area of the cambium layers in contact. Wax (preferably melted wax) is then applied over the point of union. When tying the stock and scion or applying wax, care should be taken to prevent a displacement of the two as no union will take place if the cambium layers do not fit closely. After the scions start to grow they should be examined to see that the material used in wrapping the grafts is not injuring the branches by acting as a girdle at the point of union. It is advisable to cut all such tying material a few weeks after the scions begin to grow. If more than one bud grows the strongest should be selected and the weakest rubbed off.

Bark Grafting

Bark grafting, though not so well known as cleft grafting, is a good method of top-working fruit trees. This method has several points in its favour.

(a) A larger area of the cambium layer of the scion may be brought into contact with the cambium layer of the stock, thus increasing the likelihood of a union.

(b) It is not necessary to split the branch to receive the scions and hence a more complete and rapid healing of the stub is made possible.

(c) Trunks or branches too large for cleft grafting may be readily grafted by this method.

(d) Several scions may be inserted on medium or large sized branches, thereby multiplying the chances of success.

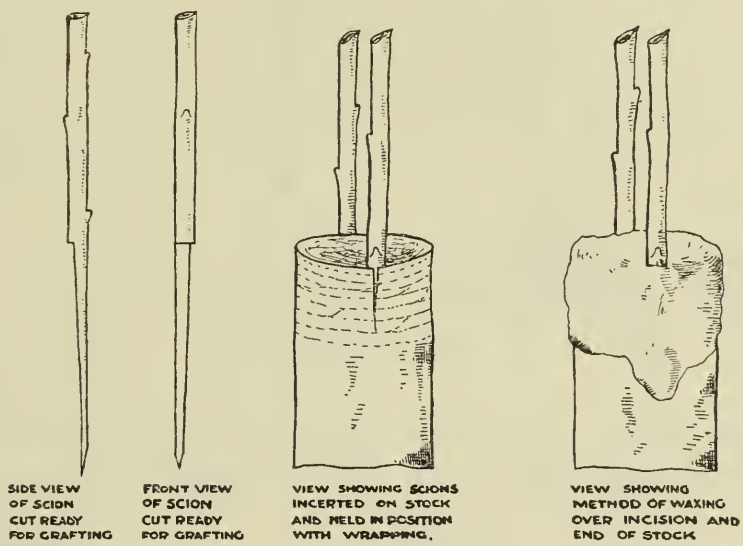
(e) The work can be easily and quickly done.

In bark grafting the branch is prepared for the scions by cutting it straight across as in cleft grafting. Where it is desirable to graft the trunk or an upright growing branch, the cut should be made at a slight angle so that rain may run off readily.

The scions for bark grafting may be prepared in various ways, but the best method is to make a straight sloping cut about two inches long at the lower

end and then cut a shoulder at the top of this wedge by cutting about half way across the scion. From this point the scion is again cut to a wedge-shape, and one side of the wedge is slightly pared off just enough to expose the cambium and to make a straight surface which will closely fit against the bark when the scion is placed. A small bit of bark should also be shaved off the tip of the wedge to allow of the cambium coming in contact with the cambium of the stock.

A slit about one-and-one-half inches in length is made longitudinally in the bark of the stock. The bark on one side of the slit is then raised, and the scion is inserted by shoving the wedge down under the bark so that the straight side of the wedge closely fits against the bark which adheres to the stock. The scion is held in place by wrapping with raffia, string or narrow bandages. Wax



Bark Grafting.

is then applied in liquid form with a small paint brush to the end of the stub and over the incision in the bark. The tip of the scion should also be coated with wax.

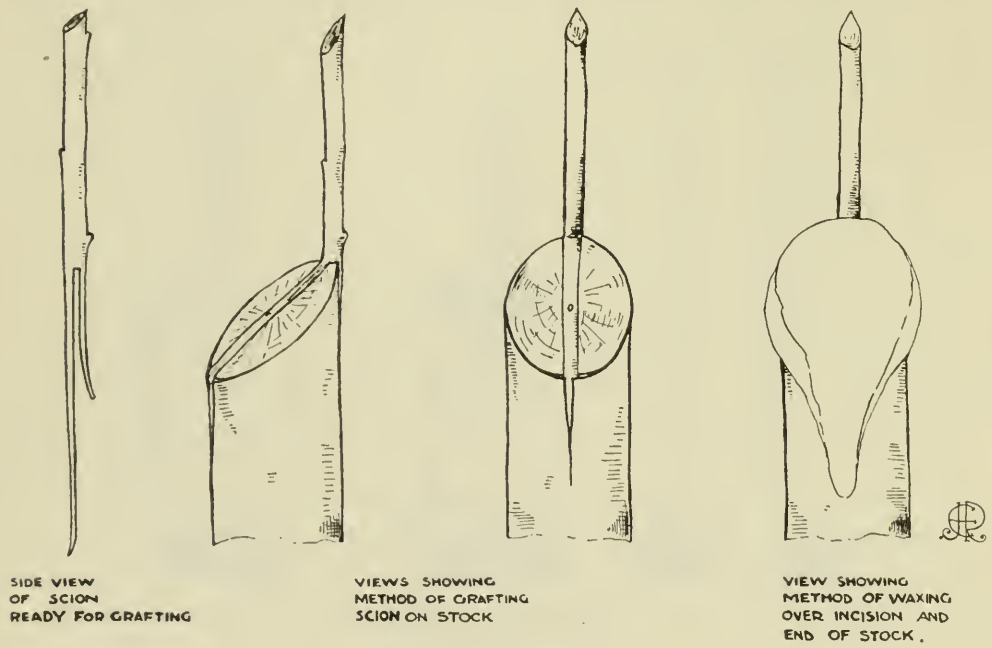
As previously stated several scions may be set in a medium or large branch. A good rule to follow in this method is to place two scions on a two-inch branch or trunk and an extra scion for each additional inch in the diameter of the stub. Later on when these begin to grow all but one should be cut off. In removing the extra scions one should make the cut about one-half an inch from the end of the branch thus leaving some growing tissue which will help to heal over the cut end of the branch. If sprouts grow on this short stub they should be removed.

Strap Grafting

Strap grafting is in reality a form of bark grafting. It is called strap grafting on account of the strap-like part of the scion which extends across the end of the stock branch. The branch is prepared for the scion by cutting it either squarely or obliquely across, and the end of the branch is then made smooth with a sharp knife, the edges of the bark being slightly rounded. Scions for strap grafting are made longer and are more difficult to prepare than scions for bark and cleft grafting. The scion is prepared by splitting it lengthwise, the split being made so as to divide the lower section of the scion into two unequal

parts, one a thin section with a bit of wood attached to the bark, and the other a thicker part containing most of the wood. The thick section is then shortened leaving a stub about two inches long. The thin strap-like piece is bent at right angles to the scion, and a cut made across the scion about two-thirds of its diameter at the point where the thin section joins the main part of the scion. From this point the short section is then cut to a wedge shape similar to the wedge made in bark grafting.

A longitudinal slit is made in the bark of the stock and the corners of which aré raised with a knife, and the short part of the scion is then shoved down between the bark and the wood directly beneath the slit. A channel is then made on the opposite side of the stock by cutting two slits in the bark, the slits



Strap Grafting.

being just far enough apart to accommodate the strap-like part of the scion. The bit of the bark between the two slits is loosened and turned outward and the strap-like portion of the scion is brought across the end of the stub and laid in this channel. The bark is then brought back over the scion and held in place by wrapping with raffia or bandages. The end of the stock and any incisions in the bark are then coatèd with grafting wax.

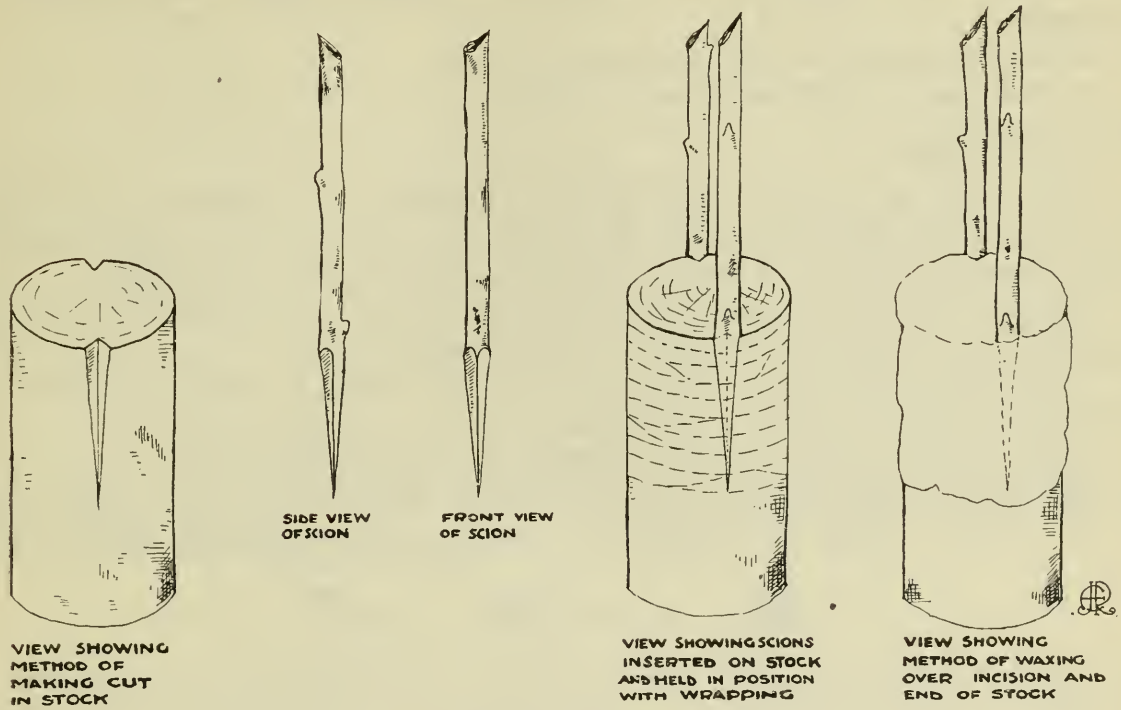
In this method of grafting the end of the branch heals over rapidly, due to the lateral growth from the strap-like portion of the scion. The disadvantages of this method are that the scions are rather difficult to prepare, and usually only one scion is put on a branch. For this reason, and partly because it is not generally known, it is not used to the same extent as bark or cleft grafting in Canada, but in Australia where this method originated it is quite popular.

Notch Grafting

Notch grafting is a modified form of cleft grafting, but differs from cleft grafting in that the cleft does not extend all the way across the branch.

A "V" shaped notch about two inches long and one-quarter of an inch deep at the top is cut lengthwise in the side of the stub. The width of this

notch will vary with thickness of the scion. Large scions of course need a wide notch and small scions a narrow notch. In any case the notch should be

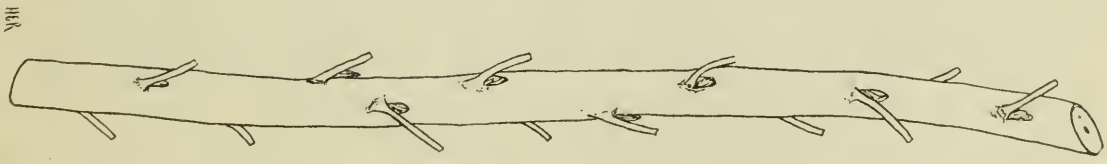


Notch Grafting.

slightly narrower than the scion to ensure a close fit. The scion is then cut to fit tightly in this notch and held in place by bandages and waxing as in bark grafting.

Budding

Fruit trees which are too small for cleft or bark grafting may be top-worked by budding. This method for small trees is considered by some authorities to be superior to whip grafting, as any buds which fail to grow may be replaced by other buds inserted in fresh bark near the point where the first bud was set. The operation can be easily done and, if care is exercised, good results may be secured. When it is desired to top-work peach and apricot trees the work is



Bud Stick.

A small branch of the current season's growth with the leaves cut off so as to leave a part of the leaf-stock on stick.

usually done by budding. These trees should be first cut back rather severely in the spring to cause a strong growth of shoots. The best of these shoots should be selected and budded in the following August and all others removed after the buds have set. In selecting shoots for budding one should choose only those which, when grown, will make a symmetrical, strong, well-built tree.

Materials Used for Budding

1. A sharp budding knife for making the cuts and detaching the buds.
2. Raffia for wrapping the branches or trunk at points where buds are to be inserted.
3. Bud sticks from desired varieties.
4. A basket or pail to carry bud sticks in.

How to Proceed

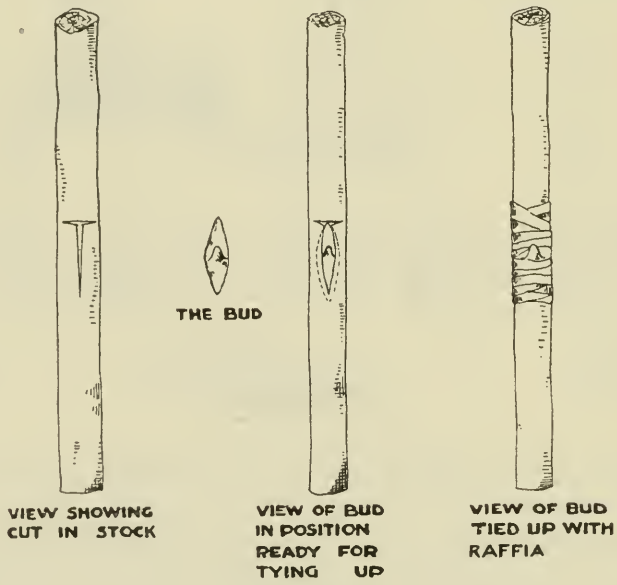
(a) From trees of the variety which it is desired to propagate, cut a sufficient quantity of well developed healthy branches of the current season's growth. These should be about one quarter of an inch in diameter at the base.

(b) Cut from the lower and upper ends about one quarter of the shoot, leaving it approximately one half its original length.

(c) Cut off the leaves, taking care to leave about one-half inch of the leaf stalk to facilitate handling of the buds.

(d) Wrap bud sticks in damp sacking to prevent drying out.

(e) Select a smooth place on the trunk of the tree or on the upper surface of the branches chosen for budding and make a "T" shaped cut in the bark.



BUDDING.

(f) Cut from the bud stick a medium sized bud. In cutting the bud, the knife should be inserted in the bud stick from one-half to three-quarter inch below the bud and drawn upward underneath the bud until the edge is about one-quarter inch above the bud, then the edge is turned at a slight angle and brought out about three-quarters of an inch above the bud. The cut should be made deep enough to include a small bit of wood. This bit of wood is sometimes discarded but is more often left on the bud.

(g) Gently raise the edges of the longitudinal slit with the wedge end of the budding knife and insert the bud by shoving it down underneath the two flaps of bark until the top of the bud is slightly below the cross cut. The projecting tip of bark is then cut off even with the cross cut and the bud pressed down. In some cases the point of bark is cut off before inserting the bud. In either case, enough bark should be left above the bud to allow the raffia to be bound over it between the bud and the cross cut.

(h) Wrap the stock above and below the bud with raffia, taking care not to cover the bud in so doing. The raffia should be tight enough to hold the

flaps of bark firmly in place over the bud, but should not be too tight as it may interfere with the growth of the bud. The bud should unite with the stock in from two to three weeks, and after that time, the string or raffia should be cut to prevent injury to the bud. The small leaf stalk will fall off if a union takes place, but if the operation has not been successful, it will continue to adhere to the bud. Early next spring the branches or seedling trunk should be cut off a few inches beyond where the bud has been inserted. This stub beyond the bud will serve as a support to which the growing shoot may be tied to prevent it blowing about during the first season of growth. Late in the summer of the first year's growth, or in the second spring, after the bud has grown for one season, the stub should be cut off just above where the bud has been placed.

Small trees up to one inch in diameter may be top-worked by inserting four or five buds on the trunk at intervals of five or six inches, each bud being placed on a different side of the tree, where it is desired to have a branch appear. In this way, it is possible to have a strongly built and well balanced tree when the buds develop into branches or have a high or low headed tree by placing the buds high or low on the trunk. After the buds begin to grow the trunk should be cut off just above the topmost bud.

Care of Top-Worked Trees

Fruit trees top-worked by any of the methods previously discussed will require some care during the first and second year after being grafted. Branches which have been cut back for grafting will usually throw out several shoots. These should be removed shortly after they appear and every opportunity given to the scions to make a strong growth. In the spring of the second season after the grafting has been completed, remove such branches as were left to absorb the sap flow or to carry on growth processes, and any shoots which may have appeared during the preceding summer. Branches on which scions failed to grow should be again cut back and regrafted.

The new growth produced by the scions should be pruned in such a manner as to form a well balanced tree with a moderately open top to admit of sunlight and air.

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(2) REPARATION

Many valuable fruit trees are lost from time to time through damage being done to the bark on the lower part of the trunks by various agencies, such as rodents, insects, plant diseases, mechanical injury or climatic influences.

Examples of Trunk Injury

(a) Rodents. Mice or rabbits often partly or completely girdle the trunks of trees at or near the ground during the winter.

(b) Insects. Bark borers sometimes girdle trees by tunnelling the bark, thus checking growth or killing the bark outright.

(c) Disease. Bacterial blight of the pear and apple occasionally destroys part of the bark on the trunks of trees while the bark near the ground or on the limbs above may be uninjured.

(d) Winter Injury. Certain varieties of apple such as the King, Ontario and Grimes Golden are subject to a form of winter injury known as collar or crown rot. The bark just above the crown or collar may be partly or wholly

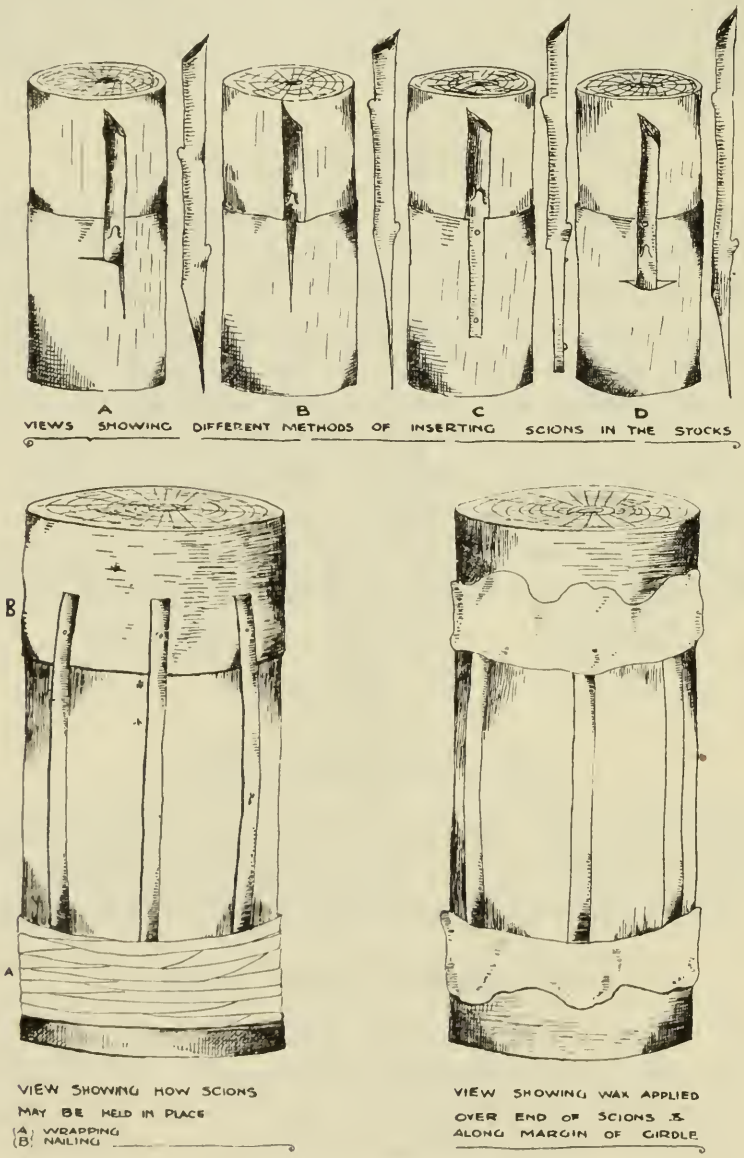
destroyed by the action of low temperatures. Another form of winter injury is known as "Bark Splitting." In severe cases, the bark will split vertically in several places, and it may also be separated from the wood for several inches up and down the trunk.

(e) Mechanical Injury. The bark on fruit trees is occasionally damaged through the carelessness in handling tools and implements.

Bridge Grafting

Trees injured by any of the fore-mentioned agencies may often be saved by bridge grafting.

Just before the grafting is to be done, both edges of the injured area should be cut back in an even line to the uninjured, healthy bark, the sections between these margins cleaned of bits of bark and covered with one or more coats of white lead and linseed oil or a thin coating of liquid grafting wax.



Bridge Grafting.

Scions for bridge grafting may be taken from last year's growth on healthy, vigorous growing trees of the same kind, but not necessarily of the same variety. They should be long enough to extend at least one inch and one-half above and below the margin of the girdled area.

There are several methods of preparing and fitting scions in bridge grafting which may be used with a fair degree of success, provided the work is properly done.

Method A. A "T" shaped cut is made in the bark about an inch above and below the edge of the girdle, the upper one being in the form of an inverted "T" thus ⊥. One corner of the bark in each of the "T" shaped cuts is then raised with the knife and the scion inserted underneath the raised portion and nailed as in method 1.

Method B. The scions are cut to a wedge shape at both ends by making a sloping cut one and a half inches long on one side with a short cut on the other side of the wedge. Vertical incisions about an inch long should then be made in the bark above and below the wound at the points where the scions are to be inserted and the bark raised by inserting a knife blade between the bark and the wood. The ends of the scions are then shoved under the bark at this point with the long side of the cut next to the wood of the tree. A small brad or nail should be driven through the scion into the wood to hold the scion more firmly in contact with the cambium layer of the stock; or, if a nail is not used the scions should be held in place by wrapping with waxed bandages or cord.

Method C. A narrow vertical channel about an inch long is made in the bark above and below the girdled area. The ends of the scions are then cut on three sides so as to fit snugly in this channel and are fastened in place as described in method 1.

Method D. The scions are prepared as in method B and inserted in a sloping incision made in the bark about an inch above and below the girdle.

Method E. Owing to the extensive areas of injury which sometimes occur on tree trunks it is not always practicable to use scions as previously described. In such cases the orchardist overcomes this difficulty by planting a one or two-year old tree of the same kind near the base of the affected tree. The top part of the trunk of the small tree is cut in the same manner as the scion in method B, and is then inserted in a cleft made in the living bark of the larger tree above the injured area as in method D.

Scions may be placed as closely as one inch apart if the work is carefully done, but the beginner may get better results if a two-inch space is left between the scions. If placed two inches apart a tree four inches in diameter will require about six scions. When the scions have been placed, a coat of grafting wax should be applied over an area extending one inch above and below both margins of the girdle, to prevent the scion and the stock from drying out. Any buds which grow on the scions should be rubbed off as soon as they appear.

If the trees are only partly girdled they may recover without bridge grafting. In such cases the girdled area should be treated the same as if the trees were to be grafted.

Paints containing benzine or turpentine should not be used as these are injurious to the bark.

Where the trees have been completely girdled by rabbits, mice or other agencies, and are not more than two or three years old, it might be better to dig them up and replace them by new trees. If the injury is some distance above the crown the tree may be saved by sawing off the trunk and cleft, or bark grafting with the desired variety, or one may dispense with grafting and take a chance on good, strong sprouts developing on the uninjured part above the original bud or graft. The best one of these sprouts should be selected for the new trunk.

How to Prevent Girdling by Rodents

The girdling of fruit trees by rodents may be entirely prevented by wrapping the trunks with wire cloth or a fine meshed galvanized wire screen, such as is used in the manufacture of window screens. These materials can usually be purchased at a moderate price and when properly applied will prove durable and very satisfactory. The wire cloth or screen should be long enough to extend from the ground to a point above the snow line, or nearly up to the first pair of limbs, and wide enough to wrap around the trunk with some allowance made for the diameter growth of the tree. After the wire cloth or screen has been wrapped round the trunk, it should be tied with a fine wire to keep it in place. Tar paper or heavy building paper are frequently used for this purpose, but neither of these is so durable and satisfactory as wire. Furthermore, if tar paper is used, sunscald is likely to occur, due to the greater absorption of the heat rays of the sun by the black paper.

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(3) PROPAGATION

Fruit and ornamental trees or shrubs which cannot be economically propagated by other means can be quickly reproduced by various forms of grafting. Whip grafting on seedling roots and budding on seedling trunks are the methods most extensively used in the propagation of fruit trees.

The propagation of fruit trees on a commercial basis is a special business which requires expert knowledge and for this reason it is not usually undertaken by the fruit grower, but is carried on by nurserymen. It usually will not pay the grower to propagate his own fruit trees, but if one so desires, it may be done. Ontario fruits are propagated by budding or root grafting on suitable stocks.

The following table will show the methods used for the tree fruits grown in Ontario:—

Kinds of Fruit	How Propagated	When Propagated	Stock Used	Stocks Produced from
Apples				
a. Standard.....	1. Root Grafting 2. Budding	Jan.—Feb. August	French or American grown seedlings or Siberian crab	Seeds
b. Semi-dwarf....	1. Root Grafting 2. Budding	Jan.—Feb. August	Doucin apple	Mound layers
c. Dwarf.....	1. Root Grafting 2. Budding	Jan.—Feb. August	Paradise apple	" "
Pears				
a. Standard.....	1. Root Grafting 2. Budding	Jan.—Feb. August	French grown Seedlings Kieffer pear	Seeds "
b. Dwarf.....	1. Root Grafting 2. Budding	Jan.—Feb. August	Angiers quince	Mound layers
Plums				
a. European.....	1. Budding	August	Myrobolan plum	Pits
b. Japanese.....	1. Budding	"	Mariana "	"
c. Americana.....	1. Budding	"	Americana "	"
Cherry				
a. Sweet.....	1. Budding	August	Mazzard Mahaleb	Pits
b. Sour.....	1. Budding	"	"	"
Peach.....	1. Budding	August	Seedling peach	Pits
Quince	1. Budding	August	Angiers quince Common quince	Mound layers Cuttings or seed

Budding

Budding is a common method of propagating fruit trees, especially peach, cherry and plum. The style generally used is shield budding, so-called, because the bud when properly cut from the bud stock resembles a shield. Young seedling trees are used as stocks on which to bud the desired varieties. The stocks are prepared for budding by stripping leaves from the trunk to four inches above the ground a few days before budding is to be done. This is done to give a clear smooth place in which to insert the new bud and to prevent the old buds interfering with the growth of the new bud after it has been placed. The method of procedure for this purpose is the same as described in top-working the trunks or branches of small trees by budding. The bud, however, should be placed on the north side of the seedling tree, not more than three inches above the surface of the ground. When the bud has been set, it is wrapped with raffia to hold it in place. In two or three weeks, the bud will have formed a union with the stock after which the raffia is removed. The stock is cut off above the bud early the following spring. In a year or two the budded trees are ready for planting.

Root Grafting

This method of propagating fruit trees is extensively used in Canada for apples. The roots which are used as stocks are usually obtained from France, and occasionally from the United States, but may be produced by sowing seeds of standard sorts or of the Siberian Crab (*Pyrus baccata*). Seedling trees for root grafting should be dug up in the fall and heeled in, in sand in a cool cellar until wanted for grafting. During January or February the trees are taken out and root grafted by the whip and tongue method. A small section of root three to four inches long, is used as stock or a whole root may be used. The method of cutting and fitting the stock and the scion is the same as described under the section on top-working by whip grafting. The stock and the scion are then wrapped with string and coated with wax at the point of union after which they are set away until spring. By this time a union will have taken place, after which the string is cut, and the grafts are planted in a nursery row. If own-rooted trees are desired, these may be produced by using scions from eight to twelve inches long and planting deep, with only one or two buds above the surface of the ground. The scions of some varieties will produce roots and in the cases of hardier sorts, the result is a tree which suffers less from root killing.

Grafting Waxes

There are several formulae for making grafting waxes, a number of which are given herewith.

1. *Hard Wax:*

Resin (crushed)	4 parts by weight.
Beeswax	2 " " "
Tallow	1 part " "

Melt together in a kettle, stirring frequently to secure an even mixture. When melted pour a small quantity at a time into a pail of cold water. Grease the hands and pull the wax like taffy, until it becomes uniform in texture. For convenience in carrying, it may be moulded into balls weighing about 1 lb., and then wrapped in oiled paper.

2. *Soft Wax:*
   Resin 5 parts by weight.
   Beeswax 1 part by weight.
   Boiled linseed oil 1¼ parts by weight.

3. *A formula for melted wax is as follows:*
   Resin (crushed) 6 pounds.
   Beeswax (finely cut) 1 pound.
   Linseed oil 1 pound.

Melt the resin and the beeswax together. Stir in the linseed oil and the wax is ready for use. If this wax is allowed to cool before it is applied it will have to be heated before using.

Waxing Pot

Where hard wax is used it will be necessary to keep it warm while being applied. For this purpose, a cheap but serviceable waxing pot can be easily made by taking an old kerosene can, cutting out the top and making eight small holes about five inches from the top, two on each side about four inches apart, and running wires through these holes so that the wires cross each other and form a frame to support the vessel containing the wax. A hole is cut in the side and an alcohol lamp or a kerosene lamp is set in the bottom to provide heat to keep the wax warm and soft. If desirable, one may purchase a special waxing pot, but this will be more expensive than the home-made one, and is not any more efficient. Melted grafting wax is usually applied with a small paint brush.

Hardy Fruit Stocks

The problem of securing hardy root stocks for propagation purposes, or hardy varieties on which to top-work other desirable and less hardy varieties, is one of great importance to fruit growers living in the northern apple growing regions of America. This problem has recently come in for consideration by several experiment stations in the United States and some valuable initial work has already been done. Much more remains to be done along this line, and many are of the opinion that a comprehensive line of investigational and research work on the fruit stock problem should be undertaken in Ontario. The writer had the privilege of spending one year in making a special study of this problem while acting as research assistant in the Pomology section of the Iowa State College. Some interesting and valuable data were obtained by original investigational work and from correspondence with fruit growers and experiment station officers in various parts of Canada and the United States. A summary of these data show fairly conclusively that some good commercial varieties of apples which are not entirely hardy can be more satisfactorily grown by top-grafting on hardy vigorous stocks planted for the purpose.

The varieties which were most frequently mentioned by correspondents as desirable stocks are as follows: 1. Hibernal, 2. Virginia Crab, 3. Tolman Sweet. The above named varieties appear to have given the best satisfaction over a wider range of territory than any other varieties listed. In the Middle Western States, the Virginia Crab and the Hibernal appear to be the most satisfactory stocks for the three leading commercial varieties, e.g., Grimes, Jonathan and Delicious, and in the Eastern States and Ontario, the Tolman Sweet appears to be the favourite for working with such varieties as the Spy, King, Cayuga, Red Streak and Bladwin. In the colder parts of Ontario, e.g., St. Joseph's Island, the Hibernal and Darts Crab are said to be the best stocks for the varieties grown there.

The common nursery practice of using French crab roots for propagation purposes is open to criticism, largely because it is believed by many that such stocks are lacking in hardiness. There is some evidence to show that own-rooted trees of hardy varieties are much more desirable on account of the greater hardiness which is secured. Some economical system should be devised of securing hardy root stocks for propagation purposes or of getting hardy varieties on their own roots to be grown either as stocks for re-working or for fruit. This important work should be undertaken by our experiment stations, and when brought to a successful stage should be adopted by our nurserymen.

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The European Corn Borer in Ontario

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INTRODUCTION

This bulletin is a summary report upon the investigations to date for the control of the European Corn Borer, and is designed to make immediately available information for the control of this pest.

Fig. 1

Fig. 2

1.—Full-grown borers and their work in a corn stalk. (A little reduced in size.)
2.—Broken-down tassel showing the whitish castings at the break and also in the enveloping leaf-base just below.

The European Corn Borer*—a whitish caterpillar, about one inch long when full grown, that bores into all parts of the corn plant—is a new insect which has been accidentally introduced into Canada and the States of Massachusetts and New York. The exact date of its introduction is not known, but the evidence tends to show that it was brought to North America about 1909 in shipments of broom-corn from Austria, where it has been a pest of corn for many years. Like a number of imported pests, it has found our climate very favourable, and as its native enemies were not imported with it, has increased rapidly and unless controlled, threatens to destroy the corn industry.

Present Distribution in Ontario and Degree of Infestation

When the borer was discovered in Ontario in 1920, the main centre of infestation was the area between St. Thomas and Port Stanley in Elgin county, but there was also a secondary centre in Welland county, nearly opposite Buffalo. The St. Thomas infestation, no doubt, originated from the broom-corn brought from Austria, but the one in Welland apparently was due to borers being brought over in table corn from the infested parts of New York state.

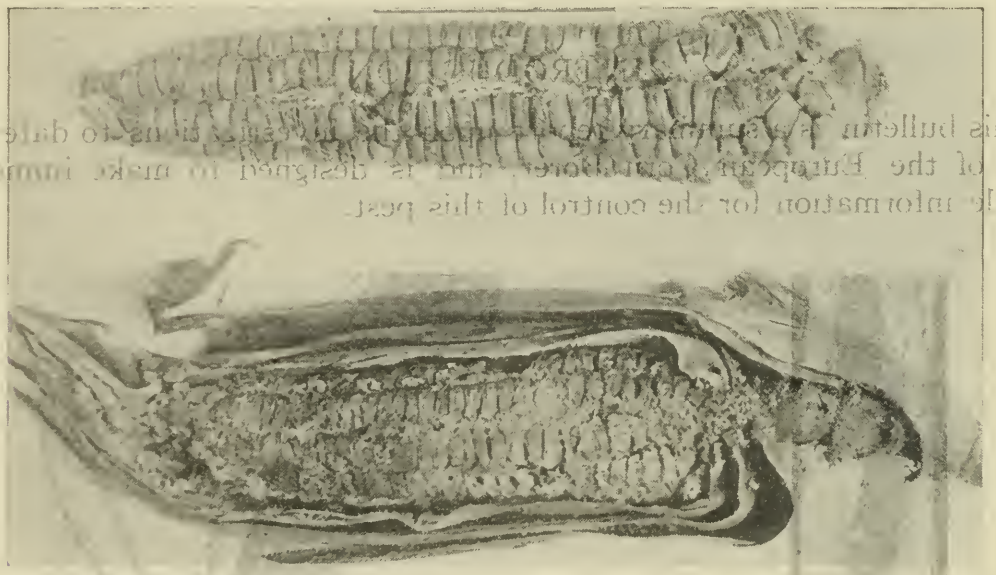

Fig. 3.—Ears of corn injured by the borer. (About half natural size.)

From these two centres, especially the former, the insect has gradually spread, as determined by scouting the last two years, until it is now widely distributed through the Province, being found in the following counties:—Essex, Kent, Lambton, Elgin, Norfolk, Haldimand, Welland, Middlesex, Oxford, Brant, Lincoln, Wentworth, Waterloo, Perth, Huron, Bruce, Wellington, Halton, Peel, York, Ontario, Durham and Northumberland.

Almost all of this area, except Elgin and Middlesex counties, is at present only lightly infested, but in these two counties, especially in the area between St. Thomas and Port Stanley, the insect is very abundant and more than 200,000 borers per acre have been found in several fields. Such fields, of course, were almost an entire loss.

Host Plants

Host plants may be divided into (*a*) those on which the insect both lays its eggs and feeds, and which therefore may be called *breeding plants;* and (*b*) those on which it only feeds, having migrated to them from its breeding plants, and which therefore may be called *food plants*.

* *Pyrausta nubilalis* Hübn.

In Europe, the breeding plants were originally hops, hemp, broom corn and millet, but after the introduction of corn (Indian maize) this latter became the favourite breeding plant.

In Ontario, so far, corn is pre-eminently the breeding plant and is also the main food plant. All varieties of corn are susceptible, but sweet corn suffers most, then flint and then dent.

In addition, oats, grown on corn stubble, are sometimes breeding plants and become heavily infested, but according to our experience in 1922 the ripening of the straw and harvesting of the crop results in the death of all the borers before they can mature; so it would appear that oats need not be feared as a breeding plant. Besides corn and oats, dahlias and mangels are the only plants on which we have found the borers breeding, and on these only rarely.

Fig. 4.—Field of corn badly broken down by the borer. This field was planted early, May 16th. Photograph taken August 19th, 1921.

There are many other plants on which the borers feed but do not breed. These are reached by migration, chiefly from corn as the main breeding plant, and consist therefore of those weeds which grow up among or alongside corn, the favourite ones being barnyard grass, pigweed and lamb's quarters. In New York, where there is only one brood of the insect each year, as in Ontario, though in hot seasons there may be a very small and insignificant second brood, the same condition prevails in regard to host plants; but in Massachusetts, where there are two broods, adults of the second lay eggs upon and the larvae work in a great number of plants besides corn, including many vegetables such as celery and beets, garden plants such as dahlias and gladioli, and also many weeds. Hence, this complicates matters, and makes the borer a greater menace in that state and its control more difficult than in New York and Ontario, where corn is at present almost the sole breeding plant.

Nature and Extent of the Injury

On hatching from the eggs, which are laid on the under side of the leaves, the larvae in many cases feed for a short time upon the leaves, eating out tiny shot-like holes, and then work their way along the leaf to the main stem and enter the unfolding tassel or the stem itself. Here they grow rapidly and usually the first conspicuous sign of their presence is the breaking over of the tassel, due to the tunnels eaten into it. The broken-over tassel soon becomes bleached and white, and thus still more conspicuous among the healthy uninfested tassels. Later the larvae either tunnel down the stem or come out and enter new places lower down either in the stem or in the ear. In these they may burrow either up or down. If there are many borers to a plant, as there will be in a badly infested field, the stem will be riddled with tunnels and entrance holes, the leaves will droop and the plant will break over in one or more places, die and dry out. The ears will have kernels eaten out in places, and, if the plant dies early, will be stunted. In the St. Thomas-Port Stanley district whole fields were so badly attacked in 1921 and 1922 that by the first of September almost every plant was broken down and the crop practically ruined. Judging from what we have seen in this part of the Province, we cannot but believe that if no control measures were adopted, the borers would gradually increase so much that corn growing would either become impossible or unprofitable. Especially would this be likely to occur in the corn-seed growing counties like Essex and Kent, where, as will be shown later, the conditions for the rapid increase of the insect are more favourable than in the counties where corn is grown for ensilage.

Life-history

The European Corn Borer, like most other insects, passes through four distinct stages in the course of its life. There is first, the adult, a moth; second, the eggs, which are laid by the moth; third, the larvae or borers which hatch from the eggs and do all the damage; and fourth, the pupa or resting stage into which the borers change when full grown, and from which the moths later emerge.

The Moths

These are about three-quarters of an inch long, have a slender body, and a wing expanse of from one to one and a quarter inches. The females are cream coloured with more or less of a brown tint and have three narrow wavy purplish-brown bands across the wings. The males are a little smaller than the females and are darker in colour, being pale brown, blotched and banded with creamy yellow.

The moths come out in June and July. The following table illustrates the normal field emergence during 1921 and 1922.

	1921	1922
Earliest emergence	June 15	June 17
Maximum emergence	June 29	July 8-12
Latest normal emergence	July 26	July 31

Wherever corn stalks are carried over in very dry places like barns, occasional moths continue to emerge from these long after emergence in the field is over. For instance, from one barn of which records were kept, moths continued to emerge until September 4. The total, however, of these late-emerging moths, is small.

The number of male moths is a little larger than that of females.

As far as observed, moths feed solely upon water, which they find chiefly in the form of dew on leaves. They fly only at night, unless disturbed, and hide during the day on the under side of leaves of corn or almost any similar shelter.

The flight habits of moths are difficult to determine fully, but observations show that no matter where they emerge, they usually fly to nearby corn fields or to fields not more than a mile or two away and gradually spread through

Fig. 5.—Adults of the European Corn Borer. The light colored moth at the bottom is a female, the two above are males. The lower two have their wings in about the normal resting position. (About natural size.)

every part of these. Occasionally they may travel long distances either of their own accord or by being carried by strong winds. For instance, in the United States marked moths have been found almost twenty miles from where they were liberated. In the case of a very light wind the general direction of flight seems to be against the wind.

The moths usually begin to lay eggs in from three to five days after emerging, but in a few cases the period has been as short as a day and a half and in others as long as eight days. Egg-laying normally continues each night until the moth dies. The greatest number of eggs laid by any one moth was 1,210; the average per moth in 1921 and 1922 was between 400 and 600.

In cages where they were given careful attention, some moths lived a month; but the average length of life for females was from fifteen to seventeen days. Males do not live quite so long.

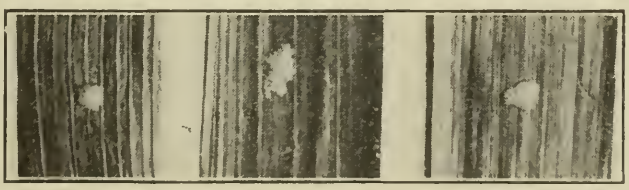

Fig. 6.—Three egg masses, each on the under side of a corn leaf. (About natural size.)

The Eggs

The eggs are laid in small irregular clusters of from three to forty eggs each. The clusters are shown, natural size, in Fig. 6. The eggs are circular, flat, glistening white and overlap like fish scales. As they mature, they become

yellowish and shortly before hatching, the black heads of the little borers inside can be seen easily. With rare exceptions, the eggs are laid on the underside of corn leaves, generally at the point where the leaf bends over. This gives them shelter; which is necessary, because the direct rays of the sun would kill them. Practically every egg is fertile and nearly all of them hatch in from three to five days.

Fig. 7.

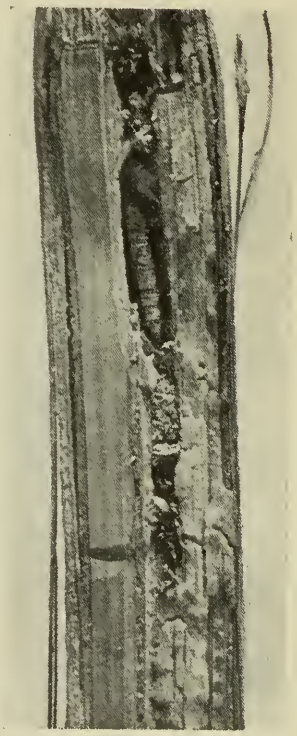

Fig. 8.

Fig. 7.—Borers and their work in stubble. Note that some of this work would be below the ground. (About two-thirds natural size.)
Fig. 8.—Pupa in corn stalk. (Natural size.)

The Larvae.

On hatching, the larvae are very small, only about one-sixteenth of an inch long. They grow rapidly and when full size are about one inch in length, smooth, pale brownish white or dirty white, sometimes with a pinkish tint. The head is dark brown and the body is spotted with numerous small brown dots. Partly grown or small larvae are usually lighter in colour with much the same markings.

In the early part of the season or while the corn is still young and tender, newly hatched larvae often eat small holes out of the upper leaves, but later in the season when the leaves are tough the young larvae do not eat holes in this way. In both cases they soon work their way to the unfolding leaves and tassel and bore into the centre. Here, as the tassel develops, some enter its stem and by their tunnelling cause it to drop over; others enter lower down and eat out burrows in the main stem. A favourite place of entry is at the joint or node where the leaf-sheath envelops the stem. The sawdust-like castings, which collect here in the axil of the leaf, are one of the easiest ways of recognizing that the plant is infested. If the infestation is heavy, borers may be found in any part of the stem including the tap-root, also in the ear-shanks and ears. In the ears the larvae eat out large or small areas among the kernels and often bore

into the cob itself. This injury to the ears is especially severe in the case of sweet corn. In both the stem and ears the injury, as already pointed out, is often made much worse by moisture getting in and leading to soft rot and mould.

In addition to the habits just mentioned, the larvae, when nearly full grown, wander around considerably from the plant on which they have been feeding and enter other corn plants or weeds growing among or close to the corn.

The insect winters only as full grown larvae or borers. They reach this full grown stage usually by the middle of August, and then stop feeding and migrating and prepare for winter. Their winter quarters are the burrows inside the plants where they have been feeding. Hence they winter in any part of the corn large enough to contain a burrow or in any of the weeds which they may have entered in their wanderings. Here each borer simply spins a little silk around itself, and then, unless disturbed or forced by excessive moisture or some other cause to seek new quarters, remains until the next spring, when it cuts a hole for emerging later as a moth, and then pupates.

Thus it will be seen that this insect passes most of its life in the larval stage, which lasts from about July one year to June the next year, or nearly eleven months.

The Pupa

The larvae begin to pupate in their winter quarters about the first of June. The pupae are about three-quarters of an inch long, cigar-shaped, and vary in colour from pale yellowish brown to dark reddish brown. As a rule between 80% and 90% of the larvae have changed to pupae by the middle of June. The pupal stage lasts from about eleven to fourteen days and at the end of this period the moths emerge.

Natural Control Factors

In Ontario so far, only a few natural enemies have been found to prey upon the European Corn Borer. Of birds, the downy and hairy woodpeckers have frequently been seen digging the borers out of the stalks and stubble in the field. In one field these birds were computed to have taken 60% of the borers during the winter months of 1921. Robins were observed eating borers which had come to the surface after a heavily infested field had been plowed down. They were also seen taking them from cages in experiments. Blackbirds were noticed in great flocks in the fall in a badly infested field of sweet corn, but it was not determined whether they were eating borers or not, though there seemed little doubt that they were. Other birds, such as kingbirds, phoebes and wrens were observed catching the moths in the morning when these were emerging. Doubtless there are several other birds, such as crows, which feed to some extent upon the insect.

Of insects, the little garden ant has been seen taking great numbers of borers out of experimental cages, some experiments being ruined by them. These ants will sting to death and carry underground into their holes any borers they find on the surface. The aphis lion, a little creature with large sickle-shaped jaws, which is the larva of the delicate lace-wing fly so common in corn fields, has been observed eating young borers on the leaves. The pink, twelve-spotted lady bird beetle (*Megilla maculata*), very common on corn leaves, eats the eggs of the borer if it happens to find them. Large dark-brown ground beetles and field crickets have been seen killing larvae which they found on the surface of the ground, but they have not been seen eating them. A small two-winged fly, nearly as large as a house fly, only darker in colour (*Exorista*

nigripalpis Towns.), is the only true parasite that we have found on the corn borer. In 1921 this fly parasitized and killed from 4% to 8% of the borers in one field, but in 1922 it was exceedingly scarce and of no account. Its life history has not been worked out in Elgin county, and it is doubtful if it will have much effect in keeping down the numbers of corn borers, because it normally lives on some other insect and apparently parasitized the corn borer just by chance. In addition there are indications that there are some four-winged parasites of the borer, but we have not reared these yet.

The above mentioned birds and insects have some effect on the borer, but not nearly enough to prevent its rapid increase.

There is, however, one weak spot in the life of the insect, and this is the fact that only about 25% of the larvae hatching from the eggs live for more than a few hours. We have not been able to determine all the factors which cause this high mortality. In many instances the tiny larvae either drop to the ground or are blown down by the wind and perish before they can get back to the plant; in others they seem just to shrivel up and die for no apparent reason unless it be that the atmospheric conditions are unfavourable. Whatever the cause of their death the fact that such a large percentage perish is a great boon and makes the problem of control easier.

Fig. 9.—A very dirty stubble field. All this stubble and debris contains borers and must be destroyed either by plowing or by burning and plowing.

Control Measures

We are still working on the problem of how to control this dangerous pest, and it will probably require several years yet before the simplest and easiest methods will have been fully worked out. In the meantime we have learned a great deal about how to deal with it, and from our experience the last two years feel satisfied that if the methods advocated below are followed they will result in its control. For perfect control everybody should do his part, and no one should neglect his own duty merely because some indifferent neighbour fails to fall into line.

Two distinct conditions may be recognized in control:

(*a*) The condition existing when corn is grown for ensilage alone.

(*b*) The condition existing when corn is grown for husking or for cutting and feeding directly to the stock without being ensiled, or where only a small part is ensiled.

The first of these conditions is a comparatively easy one to deal with; for by cutting all the corn and putting it into the silo from 75% of all the borers in a badly infested field to 98% in a lightly infested one will be destroyed, being killed either by the cutting knives or by the heating and fermentation of the ensilage. The lower the corn is cut the larger the number of borers that will be destroyed, and the fewer will be left in the stubble. Hence corn should be cut as low as possible.

Of the 2% to 25% of borers left in the field, either in the stubble or debris, almost all can be destroyed by plowing them down deeply and taking precautions not to drag the stubble up again when cultivating. The value of plowing as an aid in control will be discussed later.

We thus see that if everybody had a silo it should be a simple matter to control the borer. Hence we strongly urge farmers who have no silo to erect one, both because of the borer and because a silo is one of the most valuable factors in successful farming.

Fig. 10.—Corn cobs left lying around the barn or corn crib. These cobs may contain borers, and so must be collected and burned.

The second condition, namely, when corn is grown for husking or for cutting and feeding directly to stock without being ensiled, presents a much more difficult problem; the difficulty here being how to dispose of the stalks and remnants of the crop in such a way that all the borers in them will be killed before June of the next year and not be able to transform and emerge as moths. The silo did this for us before, but here we have no silo or, if there is one, it can handle only a small part of the crop. At first the task seemed to us insurmountable, but on further study we found that it was not so difficult as we thought and could be solved in the following way:

In fields such as are common in Essex and Kent, where the corn is husked and left standing for cattle and hogs to run in, a railroad rail or planker or leveller drawn by two teams of horses should be dragged over the field on a frosty day in winter to break the plants off close to the ground. Then these should be raked up into windrows and burned, and if necessary cross raked and the remnants burned. Then in spring such fields should be plowed deeply

thus burying everything. This method will destroy the borers almost as well as the silo and plowing would.

In this case we have assumed that the corn stalks were all left in the field, but there are many cases where the corn is cut, stooked, husked and later much of it hauled to the barn for fodder. There is also the case where the corn is grown for fodder alone and hauled to the barn but not put into a silo. In all these, the problem of destroying the borers in the stalks involves more labour, because of the various places where these stalks are scattered about and because large pieces of stalks are left unconsumed by the cattle. The method of procedure that should be adopted here is to burn in spring or winter all stooks left in the field, and to gather up and burn any unconsumed stalks or remnants left in or around the barn or wherever they may be; and also, so far as possible, to avoid throwing remnants of stalks into the manure, piling them instead upon a waggon or a stand left for the purpose and drawing them out from time to time and burning them. If it is desired, corn stalks may be run through a cutting box or shredder and any material thus treated which is not eaten may be thrown out in the manure, provided that all such manure is hauled out and plowed down before the first of June.

Corn cobs also may contain borers, so these should either be used as fuel or gathered and burned.

All clean-up measures and all plowing must always be completed before June 1st, because if postponed later than this moths would soon begin to emerge and lay eggs on the new corn crop.

The Value of Plowing

Plowing acts in two ways: First, it causes nearly all of the buried borers to come to the surface, and, if there are no stalks left there into which they can crawl, they perish either from exposure or from the attacks of enemies such as birds, ants and beetles. Second, it kills any borers that do not come to the surface.

As far as we know at present, the best time to plow is early in the fall, just as soon as the crop can be removed and while the ground is still warm, or in the spring.

The objection to late fall plowing is that a large percentage of borers would remain dormant in the soil until the next spring, and then would come out and as a result of the washing of spring rains and the heaving of stubble would find shelter and survive.

Plowing to be most effective must turn everything down completely. To accomplish this, rolling as soon as the crop is off will help by breaking down almost all stubble and rendering it more easily turned under. A wide-furrow plow with a skimmer appears to be the best type to use.

The method of cultivation following the plowing is of importance, for if a toothed implement is used, it will drag up stubble or other remnants and thus defeat the object, since the borers in these may still be alive and survive; also borers that have come up after being buried will find hiding places in them. The best implement appears to be the disc, and a disc drill should be used in sowing the field.

With the same object of keeping the stubble under, it stands to reason that a hoed crop should not follow after corn, because the amount of cultivation necessary would be sure to drag up the buried stalks.

Sometimes in spite of the utmost care in plowing and cultivating, a con-

siderable amount of stubble and pieces of stalk will be brought to the surface. This should be picked off by hand as soon as the new crop has been sown. Our experience in 1922 showed that in many cases a man could pick all this debris off a field at the rate of three-quarters of an acre per hour.

Choice of Variety in Relation to Control

Numerous observations have shown that dent corn is not so severely injured as flint; hence wherever it can be done it will make control easier if dent is substituted for flint.

Small Garden Plots of Sweet Corn a Menace

In almost every garden on the farm or in villages or towns a few hills of sweet corn are grown for table use. These plots if not properly looked after may be a means of breeding the insect in large numbers. The proper course to follow is to pull all such corn when dead and also the weeds alongside and burn them as soon as they are dry.

Fields of commercial sweet corn should be treated like other fields mentioned above.

Late Planting and a Trap Crop as Aids in Control

The last two years' experience has shown that the late planting of corn in the worst infested districts has been very effective in materially reducing the damage from the borer. It has been proven time and time again that even a week's delay in putting in the new crop has resulted in much less injury than would have ensued if the crop had been sown at the regular date of planting. In this connection, it is very important that a trap crop be sown at least a week before the regular planting date for each locality and that this trap crop consist of at least ten rows of corn sown down the edge or the centre of the field, to be followed by the regular crop, which should be sown a full week later than the usual date, so as to give the trap crop about two weeks' start. The trap strip should be cut at intervals as wanted, starting about the first of August, and fed to stock, and the remains, if any, gathered up into a heap and burned. The object of the trap crop is to attract the moths to lay their eggs upon it, and then by feeding it early destroy the larvae contained in it.

It is impossible to set any date for late planting. Every farmer should plant just as late as experience shows is safe for his district. In Elgin county, it was found in 1921 that corn sown as late as the 7th of June matured satisfactorily and produced a good crop.

The Planting of Late Sweet Corn

Since the moths lay their eggs chiefly in early corn and largely avoid the later planted fields, sweet corn sown about the 15th of June would practically escape injury and would serve for a late market.

Summary

In conclusion, we advocate the increased use of the silo; the destruction by burning of all refuse corn stalks and cobs; the complete plowing under of all refuse on the corn field; and the planting of the new crop as late as possible with a small trap crop as early as possible.

Ontario Department of Agriculture
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SWEET CLOVER

SWEET CLOVER ON THE COLLEGE FARM.

Sweet Clover Hay.

Sweet clover is not a new crop on the College farm. Several years ago it was grown as a hay crop with good success so far as yield per acre was concerned, but with rather doubtful value owing to the difficulty in curing. The crop has to be cut early in June, and at that season rains are more frequent than later, and, coupled with the very sappy condition of the clover, render proper curing very difficult. Some of this eight-year-old sweet clover hay is still in the dairy barn. It is coarse and woody, and about the only way it can be used for feed is to run it through the cutting box and mix it with other feed. In the long state it does not make good bedding. This was of the yellow blossomed variety.

Small quantities of white blossomed sweet clover have been cured into hay on the College farm in each of several recent years. In 1920 five loads of white blossomed sweet clover were harvested as a second growth after pasturing. It was not good hay. Cut late in the summer, the weather for harvesting was good, but the proportion of leaf to stalk in the hay was low and the feed was woody in nature and had to be cut before the beef herd, to which it was fed, would clean it up without too much waste. In 1922 an acre and a half of the white blossomed variety was cut on June 19, when it was in the late bud stage, which seems to be the best time to cut for either hay or silage. This plot produced four tons of hay of about as good quality as could be expected from sweet clover. It was cut on a Monday forenoon, and was raked up rather green on Wednesday afternoon, and lay in the windrow until Saturday afternoon. There was no rain during the entire week, and it took five and one-half days of the best of drying weather to get the hay at all fit to go into the barn. Notwithstanding the fact that the clover was rather fine in the stalk for sweet clover, and unusually leafy, the hay came into the barn quite coarse and woody in appearance, and not what the practical man would call good hay. In feeding out, the dairy cows ate it well and seemed to relish it, but not as much as they do alfalfa, red clover, or well cured mixed hay. Considerable of the stalks also went to waste.

An analysis of the crop from which this hay was made showed it to be of fine quality for sweet clover. It produced just over seven tons of green feed per acre, and the one and one-half acres produced four tons of dry hay as harvested. Of leaf growth, the crop showed 44.68 per cent. in the green state and 55.32 per cent. stalk. The analyses of stalks and leaves from the crop show the importance of thick sowing to produce a fine stalk and an abundance of leaf growth, for the real feed value is in the leaf. They also show the necessity of preserving the leaves in harvesting.

Analyses of Sweet Clover Stalks and Leaves on the Green Basis.

	Stalks	Leaves
	%	%
Moisture	75.69	78.76
Protein	2.03	6.60
Fat	.62	1.86
Fibre	11.89	2.14
Ash	1.04	2.03
Carbohydrates	8.73	8.61

The seven-ton crop would produce approximately 6,255.20 lbs. of leaf and 7,744.80 lbs. of stalk per acre in the green state. True, heavier crops of sweet clover are grown, some reporting 10 tons of green feed per acre, but 7 tons is a fair average crop cut before the blossoms appear.

From experience on the College farm the writer has no hesitancy in saying that as a hay crop sweet clover is of doubtful value where alfalfa, red clover or good mixed hay will do at all well. Sweet clover must be cut early before the blossoms open, is very hard to cure and makes a coarse hay, although the yield is generally high. On soils where other clovers fail, and where good weather is had for curing, it may have some place, but it cannot be recommended as a general hay crop for Ontario.

Sweet Clover for Pasture.

From experience on the College farm and from observation over the Province, it would seem that if sweet clover is to find permanent favour with Ontario farmers it must be as pasture, particularly for dairy cows and hogs, as a soil builder or green manuring crop, and possibly as silage. As a pasture crop it has been given a thorough trial at the O.A.C. In 1919, 22 acres of oats sown at 2½ bushels per acre were seeded with white blossomed sweet clover at 18 lbs. per acre. The sweet clover seed was scarified, as it had been found that a stronger and more uniform germination resulted where this was done. It was sown on a rather low lying underdrained field, and wintered well. It was slow starting in the spring and was not turned on the following spring until June 5. It was the sole pasture for 44 dairy cattle and 8 brood sows from that time until August 15, and there was plenty of good feed for all this stock during the entire period. It furnished all the feed that the cows got during the entire period, and the milk flow was well maintained. The brood sows did well for the whole period. The clover averaged up to a man's knees when turned upon. There is a difference of opinion as to the proper stage at which to turn in to the crop. Where not more than a cow per acre is pastured it should be turned on when about six inches high, as if it gets too great a start it will become coarse and woody. Moreover, when kept down, a fresher growth keeps coming on. But where two or more cattle per acre are pastured, more start is required or the field is likely to be quickly picked bare.

In 1920, another 20-acre field was seeded to white blossomed sweet clover with oats as before the rate of seeding being 15 lbs. per acre. This did not give as good results in 1921 as had been the case in 1920. Forty-five head of dairy cattle pastured on it for about five weeks, starting the first week in June. The clover did not winter quite so well as was the case the previous year, and the dry weather seemed to retard its growth after it was eaten down. It was noticed, too, when the cattle were on the sweet clover exclusively that, while they seemed fairly contented and milked well, their coats became starey and they gaunted considerably. As soon as they were taken off the sweet clover and went on the aftermath in the hay fields, while they gave no heavier flow of milk, they filled

up and showed a better general appearance. After the cattle were taken off the sweet clover it was allowed to grow for a few weeks and cut five loads of rather inferior hay.

In 1921, the same 22 acres as had been seeded in 1919 was again seeded to sweet clover at the rate of 15 lbs. per acre, with oats as before. This crop was up to a man's knees by May 31, 1922. On that date 16 acres of it was fenced off for pasture, and 64 head of dairy cattle were turned on. The growth was luxuriant, fine and very leafy. It carried four cattle to the acre until July 1, when all the milking cows were turned in 20 acres of annual pasture, consisting of oats sown at the rate of three bushels per acre and biennial sweet clover at 15 lbs. per acre. Twenty-five head of heifers were left on the sweet clover for a week longer and then it was given a rest. By July 20, there was evidence of new growth on the clover, and it was used later for fall feed but did not produce a great deal of late pasture.

In this pasture scheme a two-year rotation is followed:—oats seeded with sweet clover one year, followed by the sweet clover pasture. Some of the clover seeds in the pasture, and so the seeding is not made so heavy. However, seeding is always made heavy enough to insure a thick stand. Thin stands are useless. On fields far from the barns, this rotation proves valuable as a soil builder. Very heavy crops of oats have each year followed the sweet clover. Growers must, however, not attempt to plow down sweet clover the same fall that it is seeded. If they do it will come up in the next year's crop, and give a great deal of trouble. Fall plowed after being pastured or cut for hay or silage in the following year it gives little or no trouble.

Sweet Clover Silage.

Much difference of opinion exists regarding the value of sweet clover for silage purposes. To give it a fair test, five acres of the crop on the College farm was ensiled in 1922. This had been seeded the same as for pasture and hay, and was a thick, fine, leafy stand although not an overly heavy crop. On June 15, a road was cut around the 5-acre strip with the mower and the binder was used to cut the crop. It required 30 lbs. of twine to tie the five acres, and took approximately five hours to cut it. The crop averaged about four feet in height, and six inches of stubble was left. It was cut when the clover was fairly dry, and no trouble was experienced with the binder in handling it even when crowded to full capacity. It was cut with a 7-foot binder. On the morning the cutting was finished, a light rain fell, and it was showery off and on until the crop was ensiled Saturday afternoon, June 17. It went into the silo quite damp and in a condition to pack well. It must be ensiled as soon as cut unless rain intervenes. It was cut in the late bud stage, only a very small percentage of the clover showing any blossom. It was finer in the stalk, and contained more leaves than one often sees on sweet clover of the white blossomed variety. The five acres produced 35 tons, 400 pounds of green clover, which, on the night it was ensiled, made 16 feet in a silo 12 feet in diameter. This was well packed, five men tramping steadily during the five hours it took to ensile it. Notwithstanding this fact, the silage settled three feet from Saturday night till Monday morning, when there was only 13 feet in the silo, and by Tuesday it was down to 12 feet. At that rate it would take about 15 acres of sweet clover to fill this silo, which is 12 feet by 36 feet. This, of course, is allowing for extra settling which would undoubtedly occur with the extra weight of silage.

In ensiling the wet clover from sheaves, care was taken to keep the sheaves coming into the cutting box straight, so that it was cut from one to one and one-

half inches in length. It was found to take greater speed on the blower to elevate this clover than it does to elevate corn. In fact, the cutting box was speeded up from a little over 700 revolutions per minute to 1,300. At the slower speed there was a good deal of trouble with blocked pipes.

The clover is heavy to handle, and it is necessary to be careful not to overload teams. Three courses on an ordinary wagon rack with the middle filled makes a good load, which would weigh about 3,500 lbs. of clover without the wagon. The 35 tons were hauled in 21 loads. It required four teams to keep the cutting box going, with a haul of about half a mile. Two men were all that was necessary to pitch in the field, with two more at the cutting box (one man to feed), and five men in the silo tramping, making thirteen men in all. The silo was filled, keeping in mind the necessity of thorough packing.

As has been previously stated, the clover was fine in the stalk and carried with that a high percentage of leaf to stalk. A test of a representative sample of the crop, of average length and quality, produced 44.68 per cent. leaf. This is a higher percentage of leaf growth than the average observer would estimate from looking at the crop.

Considerable has been written about the aftergrowth in sweet clover. In the writer's 12 years' experience with the crop, the aftergrowth has been a very small factor. In cutting for hay and silage in 1922, where the binder was used, a six-inch stubble was left, but even here very little aftergrowth came on, and where cut with the mower, practically all the plants were killed. Cutting below the bottom leaves on the stalks kills the plants and it is difficult to cut high enough to ensure a satisfactory second growth. Special devices are necessary on mowers, and a very high tilt on binders, if the plants are to be saved for a second crop. The easiest way to kill the crop is close cutting.

A Feeding Test with Sweet Clover Silage.

The sweet clover ensiled in 1922 was saved in good condition in the silo. It went in green, fine and wet, and was well packed. It came out in excellent condition. It was of good flavour and quality, and there was no mould present. In starting the cows on it, they did not seem to relish it quite as well as corn silage at first. On real cold days, when it was slightly frosted, they liked it less. However, they ate it fairly readily as they did the pasture and hay. The old idea that stock will not eat it has long since been exploded. True, some individual animals require a little educating to it, but if the feed is well saved, stock will eat it readily when once accustomed to it. But the crop has a pungent odour and a peculiar flavour, and cattle will take red clover or alfalfa hay or pasture or natural grass in preference to it. They also prefer corn silage to sweet clover silage where they can get either at will.

On December 8, seven cows (two Ayrshires and five Holsteins) from the herd were selected and put on a feeding test, sweet clover silage against corn silage. The following are the analyses of the two feeds actually fed:

	Sweet Clover Silage	Corn Silage
	%	%
Moisture	76.66	70.92
Protein	4.00	2.40
Fat	1.99	.83
Fibre	7.94	7.17
Ash	1.59	1.39
Carbohydrates	7.82	17.29

From December 8 to December 14 inclusive, the cows were put on a preliminary ration of corn silage, mangels, and hay with their regular grain ration of a mixture of bran, 200 lbs.; oats, 200 lbs.; cottonseed, 50 lbs.; and oil cake meal, 75 lbs. The amounts of grain fed per cow ranged from 8 lbs. to 18 lbs. per day. This period was simply used as a check after which the cows went on a three-weeks' period with sweet clover silage followed by a three-weeks' period on corn silage.

Sweet Clover vs. Corn Silage—Feeds and Yields for a Three-Weeks' Period.

No. of Cow	Grain	Mangels	Hay	Silage Fed	Sweet Clover		Corn Silage	
					Gain or Loss in weight	Total Milk Yield	Gain or Loss in weight	Total Milk Yield
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	307	764	210	486	+44	733.9	—10	750.2
2	168	630	210	500	+30	485.6	+ 4	475.2
3	231	658	210	490	+ 9	551.9	— 9	546.0
4	274	760	210	446	+25	678	—41	677.0
5	304	840	210	500	—13	901.9	—26	866.1
6	256	735	207	458	— 3	501.8	+26	492.6
7	286	840	204	484	+17	574.6	+28	539.3
Totals..	1,826	5,197	1,461	3,364	+109	4,427.7	—28	4,346.4

In studying the rations it will be noticed that heavy grain, root and hay feeding accompanied the silage feeding. The object was to use the regular ration along with the silage in order to ascertain the comparative values of corn silage and sweet clover silage under ordinary conditions in the dairy barn. With such heavy feeding of roots and grain one would not expect very marked advantage in silage, and yet the sweet clover silage showed up to best advantage. During the check period, the cows were on corn silage and the regular ration. A comparison of the amounts of silage taken then with the amounts when on sweet clover shows that they will not eat as much sweet clover as they will corn silage. After the check period they were put on sweet clover silage and given all they would eat of it. Then in the test they were given exactly the same number of pounds of corn silage per day as they had eaten of sweet clover silage. In feeding sweet clover silage alone, feeders have complained of constipation in their cattle. Feeding roots with the silage gets over this difficulty.

Table Showing Quantity of Silage Eaten per Day.

Cow No.	Check Period on Corn Silage	Test Period on Sweet Clover Silage	Test Period on Corn Silage
	lbs.	lbs.	lbs.
1	36.0	23.1	23.1
2	34.3	23.8	23.8
3	34.5	23.3	23.3
4	34.7	21.2	21.2
5	38.0	23.8	23.8
6	35.7	21.9	21.9
7	37.5	23.0	23.0

A consideration of the table shows that when on fairly full feed of grain, hay and roots, these cows on the average consumed 13 lbs. less sweet clover silage per day than they did of corn silage when on the preliminary feeding period, and their records showed practically the same quantity of milk per day.

During the feeding period proper, as the tables of results show, all the cows but No. 5 and No. 6 gained in weight when on the sweet clover silage following

the preliminary corn silage feeding, and even No. 6, which did not take readily to sweet clover silage, only lost 3 lbs. in three weeks. The total gain in weight for the seven cows was 109 lbs. in the three weeks. When they went on the corn silage following the sweet clover silage in the test, cows No. 1, No. 3, No. 4, and No. 5 lost in weight, while cows No. 2, No. 6 and No. 7 gained slightly, but the total loss in the three weeks was 28 lbs., making a weight difference in favour of sweet clover of 109 lbs. plus 28 lbs., or 137 lbs. Of course, it must be remembered that the cows when on corn silage in the test got only the same amount per day as they had eaten of sweet clover and not all they would take.

The difference in milk yield was not great, but showed 81.3 lbs. more for the seven cows during the three-weeks' period on sweet clover. All the cows but No. 2 freshened in the fall of 1922, and should not have been failing appreciably in flow.

Dates of Freshening of Cows on Test.

Cow. No.	Date	Cow. No.	Date
1	Sept. 11, 1922	5	Oct. 31, 1922
2	Feb. 25, 1922	6	Sept. 17, 1922
3	Oct. 26, 1922	7	Nov. 9, 1922
4	Nov. 14, 1922		

It would appear from the test that 22.8 lbs. of the sweet clover silage in this ration per cow per day gave as good results as 35.8 lbs. of corn silage per cow per day, and while on test, sweet clover pound for pound produced better results than corn silage. The analysis shows the sweet clover silage considerably higher in protein than the corn silage, but a great deal lower in carbohydrates, while sweet clover is much higher in fat. From experience in pasturing the crop and in feeding it as hay and silage, the writer is convinced that it gives much better satisfaction when fed in conjunction with other pasture or feeds.

Flavours and Milk Odours.

The Farm Department at the College have had no complaints from customers regarding the odour or flavour of milk or milk products from the herd when on sweet clover pasture, sweet clover hay or sweet clover silage. Of course, every care is taken with the milk as soon as milked that it be not left where sweet clover odours are prevalent.

Conclusions from Work on the College Farm.

The chief place of sweet clover on the stock farm seems to be as a pasture, particularly for dairy cows, as a soil builder, and, under certain conditions, as a silage crop.

As a silage crop, its main value is in districts where corn will not grow well. As a crop it may be produced more cheaply than corn, but is not likely to give as good a yield, and, besides, a cultivated crop is necessary in a good rotation. It is slightly more difficult to ensile than corn, and greater care is necessary to get it properly ensiled. It must go in green and preferably damp, and must be more thoroughly packed in order to ensure keeping qualities and safety in feeding.

In growing the crop, care must be taken to prevent its spread over the entire farm. It will make first-class silage under the best of conditions, and in feeding value the silage appears to be slightly better than corn.

Sweet clover is not a cure-all for all the fodder ills of farming, but may be used to advantage to increase soil fertility, especially on poor land, and to produce pasture, particularly on poor or rough land. Where corn, alfalfa and red clover grow well, sweet clover has a more limited value. It must be handled promptly and at the proper time. It is not a very satisfactory hay crop. Apparently the yellow flowered variety grows a finer stalk, but the white blossomed gives a larger yield per acre.

RESULTS OF RECENT INVESTIGATIONS BY THE FIELD HUSBANDRY DEPARTMENT.

The results of the recent investigations on White Blossomed Biennial Sweet Clover made in the Department of Field Husbandry, are discussed under the following headings:—Time of Seeding and Rates of Seeding; Scarified vs. Unscarified Seed; Cutting at Different Stages of Growth for Green Fodder and Hay; Cutting Sweet Clover at Different Stages of Growth for Silage.

Time of Seeding and Rates of Seeding.

Repeated tests have shown that sweet clover may be successfully sown in the early spring on a light snow covering winter wheat, with a grain nurse crop in the early spring, and also alone on a well prepared seed-bed until the end of July. A duplicate experiment was started in 1920, in which sweet clover was sown in every month of the year. In the month of April, barley and oats, and in the month of September, winter wheat and winter rye were used as nurse crops. During the other ten months of the year, sweet clover was sown alone. The average of the four tests conducted in the two years indicate that the most successful seedings were in the months of March, April and May. The March seeding was on bare, frozen ground, and the April and May seedings on a well cultivated seed-bed.

The amount of seed sown per acre of sweet clover naturally varies with the condition of the seed-bed, kind of soil, whether the seed is hulled or unhulled, and whether it is scarified or unscarified. In an experiment conducted in duplicate in which sweet clover, grown for hay production, was sown at the rates of 5, 10, 15, 20, 25 and 30 pounds per acre, the lowest yields per acre were obtained where the rate of seeding was five pounds per acre, and the highest yields where the seeding was twenty pounds per acre. The seeding of fifteen pounds produced a greater yield per acre than where sweet clover was sown at the rates of either ten or twenty-five pounds to the acre. The best quality of hay was grown where the rates of seeding were twenty and twenty-five pounds of seed to the acre.

Scarified vs. Unscarified Seed.

Many leguminous crops contain hard-coated seeds which under normal seeding conditions are almost impermeable to moisture. These hard seeds germinate slowly, and some of them may remain in the soil for weeks, months, and even years before germination takes place. Investigations at the College have shown that sweet clover contains a high percentage of these hard seeds.

A number of tests were made in each of three years to determine the value of scarified and unscarified seed. A large number of tests were made in 1920, the results of which are included in the following table:

Condition of Seed Germinated	Percentage of Germination			
	Test 1 10 days	Test 2 6 days	Test 3 8 days	Average 3 Tests
Unhulled (unscarified).....	22	15	32	23
Hulled (unscarified).....	37	42	38	39
Scarified.....	76	100	94	90

The seed for test one and test two was scarified by hand, and that for test three was scarified by the machine. The scratching being done by means of sandpaper in each case. It will be understood that the seed in the above tests were all threshed by the ordinary grain thresher before inclusion in this experiment. A No. 1 sandpaper produced the best results in scarifying sweet clover seed. Scarifying not only increases the germination of the seed sown, but insures a larger crop and lessens the possibility of sweet clover seed germinating in succeeding years.

Cutting at Different Stages of Growth for Green Fodder and Hay.

The following table gives the green fodder and hay yields in 1922 of a triplicate experiment where white blossomed biennial sweet clover was cut at five different stages of growth:

Stages of Growth	Yield of Green Fodder per acre (Tons)	Yield of Hay per acre (Tons)
Before buds started to form.....	11.73	1.80
Just commencing to bud.....	13.83	3.41
The late bud stage.....	15.10	3.57
One-half of crop in bloom.....	17.77	5.80
One-half of seed-pods formed.....	15.90	6.03

The greatest yield of green fodder was produced by cutting the crop when it was one-half in bloom, and the greatest yield of hay when about one-half of the seed pods were formed. The smallest yields of both green fodder and hay were obtained where the crop was cut before the buds started to form. The best quality of hay was produced where the plants were cut in the late bud stage. The quality of hay made from cutting when one-half of the seed-pods had formed was very poor.

From the results of these experiments and others conducted in previous years, when both yield and quality of hay are considered, the best results are obtained when sweet clover is cut in the late bud stage or just before it commences to bloom.

Sweet Clover for Ensilage.

In the spring of 1922, when the experiment was outlined for making determinations of the yields of green crop and hay at different stages of the development of the sweet clover plant, provision was also made for ensiling the crop at the same stages. The silos used were of galvanized iron of a height of approximately 70 inches and a diameter of 38 inches, securely rivetted and soldered, but open at each end. For each silo a pan was made which had a diameter five inches greater than the diameter of the silo, and with the sides of three inches in height. The pan served as a bottom for the silo, and also collected any liquid drainage from the ensilage.

The sweet clover used was the white blossomed biennial variety, and was cut when dry and free from dew. It was then taken immediately to the building, where the silos were located, and run through the cutting box, which cut it into lengths which would average about three-quarters of an inch. In filling the

silos no mechanical pressure was used, but precaution was taken to have the same man distribute and pack the freshly cut green crop in each silo. The silos had no tops on them, but were located in a dry, well-ventilated building. Only one silo was used for each condition, with the exception of the last two, when an extra silo was used for each, and to the material used in the extra silo water was added. In the case of when the crop was "about one-half in blossom," one and a half gallons of water was added for each hundred pounds of green fodder put in the silo; while to the crop which had "about one-half of the seed-pods formed," three gallons of water were added to each hundred pounds. This made seven silos in all in the experiment. Each silo was allowed to stand for two months from time of filling until time of opening.

The above experiment was conducted in co-operation with the Departments of Bacteriology, Botany and Chemistry. Each Department secured a sample of the cut green fodder which was being put into the silos, and at time of opening again secured samples of any material which they desired.

The following table gives the most important data relative to this experiment:

	Date of Filling	Total Weight of Green Fodder put in Silo	Weight of Liquid Drainage	Weight of Good Ensilage taken out	Pecentage of good Silage
		lbs.	lbs.	lbs.	
1 Before buds started to form.....	May 30	1500	78.3	1036	69.2
2 Buds forming.....	June 10	1500	28.8	1079	71.2
3 The late bud stage.....	June 15	1500	1.3	1113	74.2
4a About one-half in blossom.....	June 30	1357	....	852	62.7
4b*About one-half in blossom and 15 lbs. of water per cwt. added....	June 30	1405	8.3	1073	66.8
5a About one-half seed-pods formed	July 19	1135	....	545	48.0
5b*About one-half seed-pods formed and 30 lbs. of water per cwt. added.....	July 20	1184	5.3	349	22.6

*In figuring the percentage yield of good ensilage from these plots the total weight of green fodder and water put in the silo, less the drainage, was used.

It was found when the silos were filled that the volume occupied by equal weights in the first three stages was the same, but that the shrinkage was greatest in the early stages in which the sweet clover had a higher moisture content. The last two stages, where no water was added, furnished no liquid drainage whatever.

Description of Ensilage Taken from Silos.

Silo No. 1—Ensilage was pale green in colour, soft in texture, and possessed a decidedly acid smell.

Silo No. 2—Ensilage was pale green in colour, with fine texture, and with a mildly acid smell.

Silo No. 3—Ensilage was pale green almost yellow in colour, fine texture, and with a mildly acid smell.

Silo No. 4*a*—Ensilage possessed sufficient moisture, and resembled No. 3 in colour and smell, but was of slightly coarser texture.

Silo No. 4*b*—Ensilage possessed the same colour and texture as the last, but had a slightly more acid smell, and an indication of sliminess.

Silo No. 5*a*—Ensilage was of a light brown colour, with a greenish tinge. Was very dry and woody in texture. Possessed a very mildly acid smell.

Silo No. 5*b*—Ensilage was of a darker brown colour than No. 5*a*. The stems were still hard and brittle. Possessed a mildly acid smell, but ensilage was wet and slimy.

In considering the product taken from the different silos, the most satisfactory ensilage resulted from sweet clover put in the silos at the stages when "just commencing to bud" and "the late bud condition," and the poorest from the advanced bloom and seed setting stages. In both cases when water was added to the green crop put in the silos, the ensilage, when taken out, was somewhat slimy.

A perusal of the above table shows, when considering the five stages in which no water was added, that the greatest yield of ensilage was obtained from the sweet clover which was put in the silo when in the late bud condition and about ready to blossom; and the smallest yield from the sweet clover which had about one-half of the seed-pods formed.

SWEET CLOVER ANALYSES BY CHEMICAL DEPARTMENT.

Composition of Sweet Clover.
(Green Fodder)

The following is the composition of the sweet clover cut at the different stages of growth as determined by the Department of Chemistry:

	Before Buds Started to Form	Just Commencing to Bud	The Late Bud Stage	One-half of the Crop in Bloom	One-half of Seed-pods Formed
Date of Cutting	June 1	June 10	June 15	June 30	July 19
	%	%	%	%	%
Moisture	84.28	82.39	81.56	75.94	69.33
Crude Protein	3.43	3.40	3.14	3.50	5.44
Crude Fat	.86	.77	.79	.87	1.24
Crude Fibre	4.51	5.89	6.83	9.78	10.39
Ash	1.35	1.12	1.06	1.17	1.56
Soluble Carbohydrates	5.57	6.43	6.62	8.74	12.04

The percentage of moisture in the clover at time of cutting confirms the idea that ripening is a process of desiccation. With the smaller amount of water in the later cuttings we naturally must have a larger percentage of the other constituents. The chief characteristic factors in the composition of this plant are its comparatively high percentage of crude protein and the rapid increase in crude fibre as it advances in maturity.

Composition of Sweet Clover Silage.

At the time each cutting was made a portion was put into a small silo. About sixty days later this was taken out and analyzed. The following is the composition:

	Before Buds Started to Form	Just Commencing to Bud	The Late Bud Stage	One-half of the Crop in Bloom
Date of Cutting	June 1	June 10	June 15	June 30
	%	%	%	%
Moisture	82.92	82.77	82.59	82.14
Crude Protein	3.33	3.27	3.15	3.04
Crude Fat	1.13	.69	.63	1.02
Crude Fibre	5.15	5.64	5.98	6.28
Ash	1.44	1.38	1.12	1.29
Soluble Carbohydrates	6.03	6.25	6.53	6.23

The samples of silage from the different silos representing the different stages of growth of the sweet clover plant were found to be remarkably even in their moisture content, and, as a natural consequence, very even in their general composition. They contained nearly twice as much crude protein, about the same amount of crude fat and fibre, but much less soluble carbohydrates than corn silage.

SWEET CLOVER AND MILK.

Result of Investigation of the Effect of Sweet Clover on the Acidity of Milk.

Altogether over two hundred acidity tests were made with samples obtained as follows:

1st—While the cows were confined to winter feed of corn silage, hay (free from sweet clover), mixed chopped grain, and mangels.

2nd—While the cows were on ordinary pasture free from sweet clover.

3rd—While the cows were confined entirely to sweet clover pasture.

No purpose would be served in tabulating the figures of these tests, for in no single case, either in samples of milk from individual cows or in the composite samples of the herd, was any variation from the normal acidity of the milk recorded. The acidity of each sample of milk remained constant throughout the entire period of investigation regardless of any change in the diet. Whilst the cows were confined entirely to sweet clover pasture for five weeks, the acidity of the milk showed no variation from the time they were confined to winter feed and ordinary pasture free from sweet clover.

The question of whether or not the organic acids of silage increase the acidity has been pretty thoroughly studied. The effect of inorganic acids has also been studied and investigators are agreed that the acidity of the milk cannot be increased by the acidity of the food.

Effect of Sweet Clover on Flavour of Milk.

Flavour tests on samples of milk taken for acidity examination were made in two ways:

1st—By tasting the milk in the ordinary manner, and,

2nd—By tasting the curd made from each sample of fresh milk.

All the curds were made under uniform conditions, using standard quantities of milk and rennet, and coagulating at a definite temperature. The original object of making these curds was to find out if the feed including sweet clover affected the coagulation of milk with rennet. Interesting results were obtained and will be discussed in another publication. The curds proved very satisfactory for detecting a variation in the flavour of different samples of milk owing to the ease with which the curd was retained on the tongue while tasting. Although slight differences in flavour from individual cows were noted, in no single case could a taste or taint due to sweet clover be detected.

Opinions have been sought of investigators from various experiment stations in the United States, and all are of the opinion that under proper feeding conditions the flavour of the milk is not affected by sweet clover. It is quite possible, however, that exclusive feeding of any clover or other strong foods, such as turnips, containing volatile organic compounds, would affect the flavour of milk, especially if feeding takes place immediately before or during the process of milking. It is interesting to note that dairy stock on natural pasture feed sparingly when the milk cells of the udder become distended.

The exclusive feeding of one kind of clover or any other single food has never been advocated by practical stockmen. From the chemical standpoint there are few, if any, single feeds which provide a balanced ration. Natural pasture is composed of a variety of grasses and clovers, thus providing a balanced ration. It seems logical to suggest that sweet clover should not form the sole constituent of a diet for dairy stock any more than any other food. Providing sweet clover is varied with other foods and the main feed taken after, instead of immediately before or during milking, there should be no danger of so-called sweet-clover flavour in milk. It should be remembered that milk readily absorbs odours which affect the flavour when exposed to the atmosphere. During haying time there is often a strong odour of sweet clover pervading the atmosphere of the barn and the milk-house. Under such conditions milk left exposed would absorb a sweet clover flavour.

SWEET CLOVER EXPERIMENTS, DAIRY DEPARTMENT.

Effect of Feeding Sweet Clover on the Flavour and General Quality of Butter and Cheese Made from this Milk, Season 1922.

Tests were made by the Dairy Department during 1922 in order to note the effect of cows pasturing on sweet clover, with reference to the quality of butter and cheese produced from such milk. Part of the trials were made with milk from the College herd, and part with milk from patrons of the College dairy, some of whom allowed their cows to feed on sweet clover pasture and some of whom did not.

The tests of the College herd milk began May 25th, while the cows were in the stable part time and part time were grazing on natural pasture. After

the cows had been on sweet clover for about a week, tests were again made. During December, several lots of butter were made while the cows were fed on clover silage.

Results.—In no case of either pasture or clover silage milk was there observed any objectionable flavour on the butter, which might be attributed to the feed the cows ate. There was a tendency for rather longer time than usual required to churn, and the losses of fat in the buttermilk were rather high, but these might have been caused by some factor or factors other than the feed.

The cheese experiments showed that the milk from cows pasturing on sweet clover did not contain an abnormal percentage of acid. The average per cent. of acid in all the sweet clover lots at the time of adding the rennet was .182. The no-clover lots averaged at the time of renneting, .185 per cent. of acid. When the whey was removed, or the curds "dipped," the sweet clover lots averaged .17 per cent. of acid, and the no-clover lots .164 per cent. acidity, showing that the acid did no develop abnormally during what is known as the "cooking" stage of the curd.

The yield of cheese averaged 92.46 pounds per 1,000 pounds milk for the sweet clover lots; and 97.05 pounds for the no-clover lots, but this difference was probably due to the higher fat and casein content of the no-clover lots, the average fat percentage of which was 3.67, as compared with 3.42 for the clover lots of milk. The yield of cheese per pound of fat in the milk was practically the same for both lots.

Regarding the effect on the quality of the cheese, there was not much difference except in one lot. In the series made from College herd milk, the sweet clover lots scored slightly higher in flavour and in total score; but the average of the lots made from milk furnished by patrons of the Dairy Department of the College was higher in flavour and total score, where no sweet clover was fed. This was largely due to the fact that one lot of cheese made on June 19th had a pronounced flavour of sweet clover when scored on August 30th, and still had this flavour when scored six weeks later. While this was the only lot of cheese which showed an objectionable flavour that could be attributed to sweet-clover feeding, it indicates that there may be an element of danger in the milk for cheese manufacture when cows are feeding on rank sweet clover, as they were about the middle of June.

Taking all the tests into consideration in the manufacture of sweet-clover milk into both butter and cheese, there would seem to be no great risk of injuring the product as a result of allowing cows to pasture on sweet clover, nor in feeding sweet clover silage for the making of butter.

MICROBIOLOGY OF SWEET CLOVER SILAGE, BACTERIOLOGICAL DEPARTMENT.

Bacterial, yeast and mould determinations were made before, during and after the period of fermentation of six lots of sweet clover silage, ensiled at different dates from June 1st to July 30th, 1922.

At the time of sampling, the temperature of the silage was ascertained and the acidity determined by the colorimetric method for Ph. determination.

Bacterial determinations were made on beef extract agar for general count, beef extract gelatin for liquefier count, brom-cresol purple dextrose agar for

acid colony count, and acidified brom-cresol purple agar for the high acid resistant types of bacteria. Acid and gas determinations were made in fermentation tubes containing lactose brom-cresol-purple broth.

Yeast and mould determinations were made on wort agar plates.

Results Averaged and Summarized.

Bacteria.

The beef extract agar counts showed an increase of the bacterial content from an average of 30,000,000 bacteria per gram of cut sweet clover at time of ensiling, to 260,000,000 per gram on the fourteenth day from ensiling, after which the numbers gradually receded.

The gelatin-liquefying or putrefactive bacteria showed a progressive reduction in numbers from the first, giving a count of 8,000,000 per gram before ensiling, 1,000,000 per gram on the fourteenth day, and 500,000 per gram on the twenty-first day. At later dates, in some instances none were found, and in others they were present as spores.

The acid-producing bacteria developing on brom-cresol-purple dextrose agar showed a very rapid development during the first seven days, jumping from 9,000,000 per gram at time of ensiling to 545,000,000 per gram on the seventh day, after which their numbers slowly receded.

The high temperature, high acid resistant types, resembling *B. acidophilus* and *Bact. bulgaricum*, developing on acidified dextrose agar, showed a rapid development from none found before ensiling to 105,000,000 on the seventh day, and 207,000,000 on the fourteenth day, after which their numbers slowly receded.

Acid and gas-forming bacteria in lactose broth increased in numbers from 2,000,000 per gram on the first day to 100,000,000 per gram on the seventh day, after which the gas formers rapidly diminished in numbers to 10,000 on the twenty-first day, although acid and no gas was produced in the 1-1,000,000 gram dilutions on the sixtieth day from ensiling.

Yeasts.

For the yeast determinations, wort agar with a reaction of 2.4 per cent. was used.

No yeasts were found on any samples before ensiling, and in the majority of instances no yeasts were found at any time after ensiling. The highest number found was only 110,000 on the third day from ensiling, after which the numbers rapidly dropped to zero.

Moulds.

The same culture medium was used for the mould determinations as was used for the yeasts.

On the cut clover before ensiling an average count of 285,000 moulds per gram was obtained. Out of this number fourteen genera were identified, and three other types were observed but not identified, as they developed no spores on culture media. Those identified are as follows: Mucor mucedo, Mucor racemosus, Thammidium elegans, Penicillium, Aspergillus glaucus, Aspergillus fumigatus, Hormodendrum, Cladosporium, Fusarium, Dematium, Sporotrichium, Spicaria, Oidium lactis, Echinobotryum, Monilia and Alternaria.

Mixed mould developed to a greater or less extent in the surface layers of

the silage, but in taking samples for analysis, the surface layers were always discarded, as these should not be used for feeding at any time.

After ensiling, only one species of mould, Oidium lactis, was found at any time, and this only in small numbers. The highest numbers occurring were 600,000 per gram on the seventh day, 10,000 per gram on the twenty-first day, after which date none were found in any sample.

Acidity.

The colorimetric method was used for Ph. determination; methyl red, brom-cresol-purple and brom-phenol-blue being the indicators.

With the freshly-cut samples of clover, taken as they were being filled into the silos, a slightly higher acidity was found in the samples cut early in the season than in those cut later, those cut on June 1st and 10th being Ph. 6.6, those cut June 16th and 30th being Ph. 6.8, while the one cut July 20th was Ph. 6.9. On the other hand there was a tendency for the samples cut later in the season to produce a little higher acidity during the period of fermentation than those cut earlier in the season.

The highest degree of acidity found at any time was Ph. 4.4, and the earliest day on which this was recorded was on the fourteenth day from ensiling. Most of the acid, however, was produced during the first seven days, the average reading of the samples taken on the seventh day being Ph. 4.9.

The acidity of good corn silage is usually higher than the above, samples that we have tested for comparison giving an average of Ph. 4.0.

Temperature.

The temperatures taken eighteen inches to twenty-four inches below the surface gave 44° C on the fifth day, 45° C on the fourteenth day, 46° C on the twenty-first day, 44° C on the thirtieth day, 42° C on the fortieth day, 42° C on the sixtieth day, and 37° C on the seventy-fifth day.

Conclusions.

Sweet clover, when cut and well packed in the silo so as to exclude air, undergoes an acid fermentation in which acid-forming bacteria play an important role. Putrefactive bacteria are kept in check or destroyed as a result of the development of acid and rise of temperature; moulds are prevented from growing by exclusion of air and yeasts do not find a satisfactory condition for development, so that no loss of sugar occurs from alcoholic fermentation such as frequently occurs in corn silage where yeasts are usually present.

FORAGE POISONING.

Extracts from the Report of Frank W. Schofield, D. V. Sc.:

"The investigation into the danger of using sweet clover hay and ensilage as a food for cattle."

"Sweet clover containing mould may be poisonous to animals."

"In most cases where deaths had occurred, the sweet clover contained either a large or small amount of mould."

"It has been observed in several cases that animals being fed on sweet clover were very susceptible to simple operations."

"Death following dehorning and similar simple operations is due to lack of clotting power in the blood." "This results in the animal bleeding to death." "A poisonous substance developed in the mouldy food has the power of destroying either the blood platelets or the cells from which they arise." "As well as altering the blood, the poisonous substance in the mouldy clover seems to weaken the blood vessel wall so that rupture is easy." "The blood escapes into the tissues and the body cavities and the animal bleeds to death."

"Is sweet clover free from mould quite safe? The evidence would warrant the statement that sweet clover where free from mould is apparently a safe food for animals." "That certain organisms, most likely moulds when growing in the plant, produce either directly or indirectly powerful poisons." "That as weather conditions are less likely to affect the safe harvesting of sweet clover for ensilage, it is a safer feed than sweet clover hay."

SUMMARY.

Sweet clover has given fairly good results on the College farm as pasture for dairy cows, as a soil builder and as silage, but has not been a satisfactory hay crop.

For silage it may be grown at smaller cost than corn and, while giving some difficulty in ensiling, if cut in the late bud stage, put in green and well packed it makes silage which, in actual feed tests with dairy cows, slightly excelled a first class grade of corn silage.

Where good, germinable seed of sweet clover is used, about 15 pounds per acre is sufficient for sowing when the seed is scarified; when unscarified and unhulled seed is used, the quantity should be increased to from 20 to 25 pounds per acre.

Good results have been obtained by seeding with a nurse crop during the months of March, April and May, and without a nurse crop up to the end of July.

The best hay and silage was made when sweet clover was cut in the late bud stage and about ready to blossom.

The acidity of milk is not affected by feeding sweet clover. General investigation has proven that the acidity of milk cannot be influenced by acids in the ration.

Under proper feeding conditions the flavour of milk is not affected by sweet clover. It should be remembered, however, that milk readily absorbs flavours when exposed to the atmosphere. If milk is left exposed, sweet clover flavour might be absorbed from the atmosphere, especially during the haying season.

Microbiological determinations of six lots of sweet clover silage indicated that such silage when well packed to exclude air, undergoes an acid fermentation in which acid-forming bacteria play a predominant role; putrefactive bacteria are kept in check or destroyed; moulds and yeasts are prevented from growing. The acidity is a little lower than that of good corn silage.

Taking all the tests into consideration in the manufacture of sweet clover milk into both butter and cheese, there would seem to be no great risk of injuring the product as a result of allowing cows to pasture on sweet clover, nor in feeding sweet clover silage for the making of butter.

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COLONY HOUSES FOR SWINE

By L. STEVENSON, B.S.A., M.S.

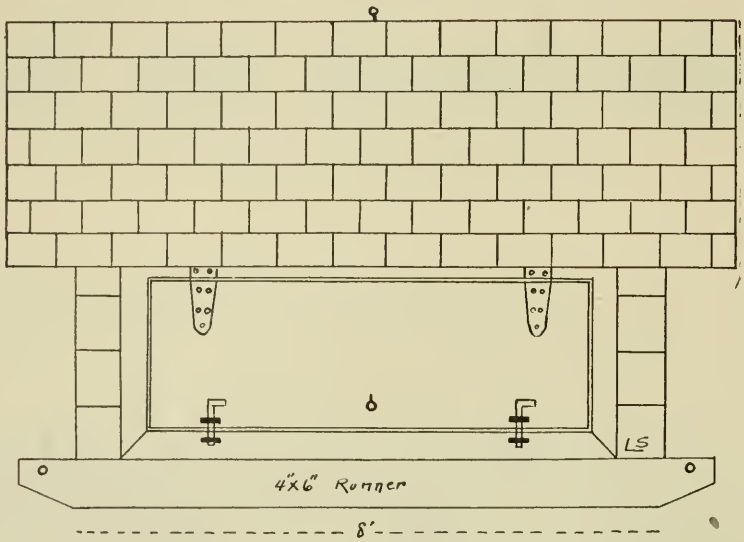
High efficiency at a very low shelter or building equipment cost is more easily obtained in swine rearing by the use of the Colony house system than any other method.

Colony House, Yard and Feeding Shed, Experimental Station, Ridgetown.

On farms where but one or two brood sows are kept, and these have to rustle around the barnyard and hunt part of their food, and arrange their own sleeping quarters beneath the straw stack, one seldom sees diseased, unthrifty or crippled pigs. In contrast to the "little accommodation" that the farmyard affords, we have the pig palaces or expensive piggeries. The best of the expensive structures do no better for us than the barnyard, when only one or two brood sows and their families are considered. Many of the expensive swine barns or piggeries have proven too heavy a charge to carry in that results were frequently unsatisfactory, and there was always an interest charge against the investment. In many of the large piggeries, it is frequently noted the very desirable, robust condition of the occupants is wanting. The pig is naturally an out-door animal, living, in its wild condition, beneath the shelter of a rock or fallen tree.

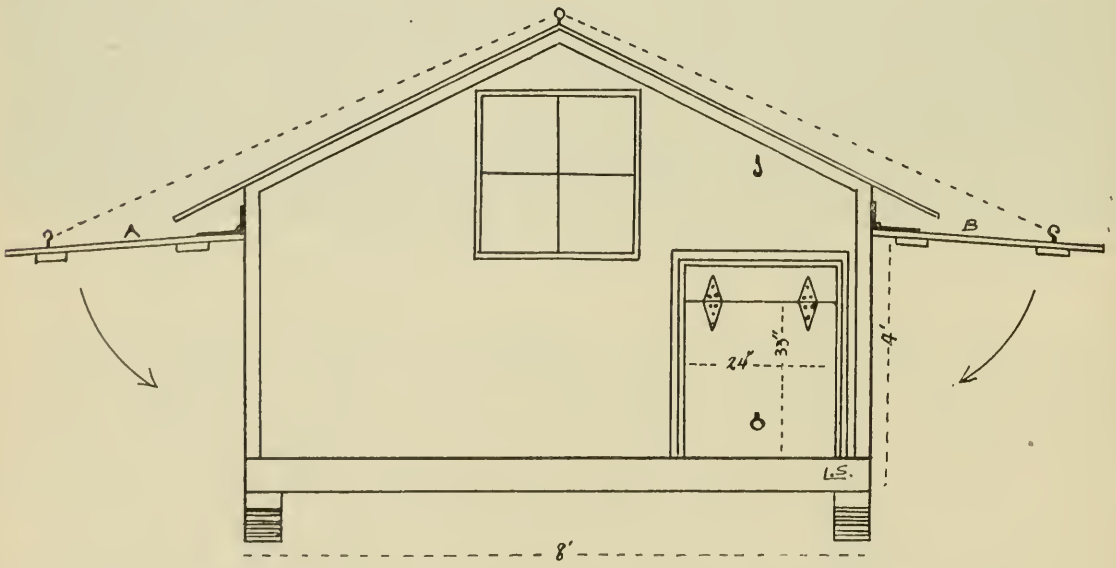
Sanitation as Important as Feeding

Sanitation is a very important factor in swine rearing; in fact, just as much so as feeding. During the summer period, when swine are given the freedom of fields or wood lot—natural conditions—the question of sanitation has not to be considered, but just as soon as a pig is enclosed, or kept under conditions that are getting away from nature, the question of sanitation at once becomes apparent, and if neglected, trouble follows. The pigs are healthy when out on



Colony House A.—Side view of Colony House showing side door closed and bolted.

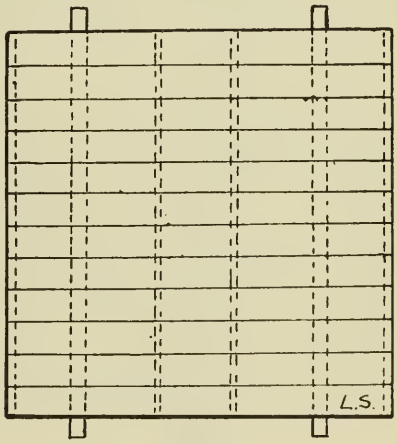
the clean, fresh soil, and the farther we get them away from such surroundings, the more likely we are to have trouble. The Colony house has been used on the Provincial and Dominion Experiment Stations with success, and its use can be extended to every farm where pigs are kept. In the milder sections where the temperatures rarely go below zero, the Colony house can be successfully used during the entire year.



Colony House A.—End view of Colony House, with side doors shown open. This type of house can be constructed so that the roof can be hinged at peak, and the roof section raised to give ample air during the hot weather. The window can also be removed. This house is best constructed 8ft. x 8ft. with 3 or 4 foot wall, single board for houses intended for summer use only, and double board for all-year houses. The window may be 4ft. x 1ft. or 2ft. x 2ft. The door should be 33 inches high to permit the passage of large brood sows.

Swine are kept by the majority of farmers with the intention that profit shall result from the undertaking. The chance of making a profit is influenced by a number of factors, one of which is the overhead or equipment charge against the operation. If a farmer has a $2,000 piggery building, then the first $200 received from swine sales each year, goes to paying interest on the building investment. If the same number of swine could be produced in buildings costing but $100, then the amount that would have to be taken from the yearly swine sales to pay overhead and interest on building equipment, would be only $10. The greater the building equipment per animal unit, the greater the portion of sales receipts that must go for that building equipment. The barnyard reared pig will have but little charged against him under building or shelter, but the barnyard capacity is generally limited to the family of one sow. Many farmers desire to keep more than one sow, hence the necessity for building equipment of some sort especially designed for the use of swine.

Twenty feet by twenty feet—The cement platform is a corn saver. It keeps the swine and their feed up out of the mud.



Twelve feet by twelve feet—Portable Feeding Floor—Dotted lines indicate frame.

A raised cement platform on which ear corn can be fed will save its cost twice over in one ear. With large feeders the waste through feeding on the mud, clay or sand is frequently rom $200 to $500 per annum, all of which could be saved by a feeding floor or platform.

Essentials that Must be Considered in Providing Shelter for Swine

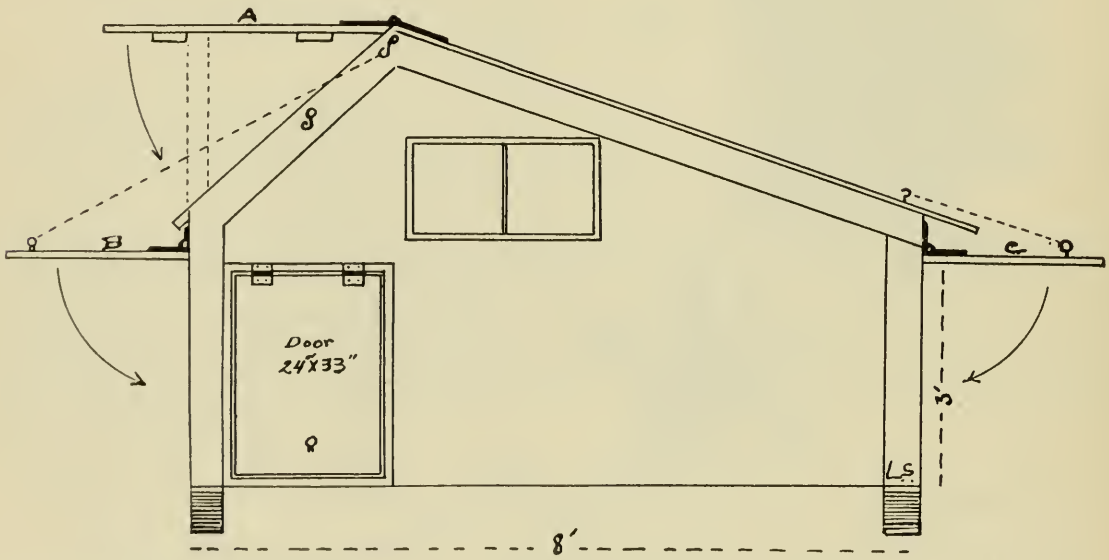
Dryness.—A dry bed on a dry floor, dry walls and ceiling are very necessary o success. Pigs do not do well in damp quarters, and attempts at feeding in uch will end in losses if carried for any length of time. The Colony house eing a very small building does not require extensive equipment for ventilation, or does it require very much care in this regard on the part of the man.

Warmth.—Pigs of all ages should be given protection sufficient to keep them rom shivering from cold. High temperatures should also be avoided. A pen emperature ranging from 46 to 60 degrees is very satisfactory for shoats and lder stock. Very young pigs require a temperature that is comfortable to hem, 60 to 70 degrees.

Ventilation.—To be thrifty, pigs must have an abundance of fresh air t all times. When sheltered or confined by any type of building during cold

weather, the ventilation should be provided in such a way that drafts of cold air will not strike the sleeping place occupied by the swine.

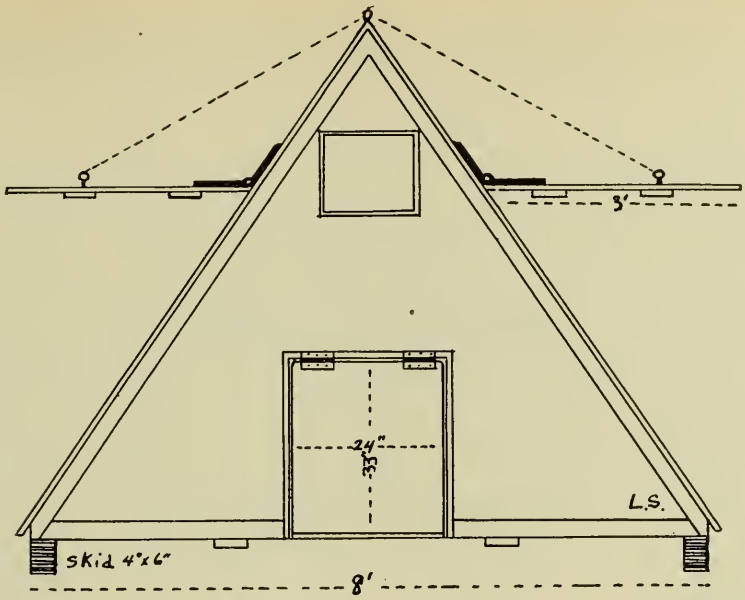
SUNLIGHT.—The Colony house, feeding floor, or pen should be so arranged that the greatest possible use can be made of the sun's rays to destroy germs, and to promote warmth and dryness in the pen during the autumn and winter. The young pig likes the sun, and its warming influence is a great stimulant to the early spring farrowed pigs. All windows and doors should be so arranged as to give the greatest efficiency in lighting; the house design should be such as to take full advantage of old Sol's furnace. Vertical walls, large windows, at proper height, and a tight, hard, smooth floor and door or doors of ample size are aids to the full use of the sun. During the warm weather period, June to September, the young pigs and breeding stock require shade from the direct rays of the sun. Such can be provided by large trees or a shed roof in the yard. Colony houses set among large trees during the summer period usually provide ideal conditions for the pigs. Tree shade in both summer and winter is very important. A spruce windbreak on the north side of the yard is an excellent background against which to locate the Colony houses during the cold period of the year.



Colony House B.—Side elevation. Side view of Ames type Colony House. Three doors open for summer use. Swine door can be hooked up and window removed. Built 8ft. x 8ft. and with a 3-foot wall. A glass sash can be framed in beneath roof door A. Doors A, B, C, can be bolted up tight for winter weather. Built single board if for summer use. Double board for winter if desired. Swing door should be 33 inches high and 24 inches wide.

FEEDING FLOOR.—Thousands of bushels of grain are wasted each year through wasteful feeding. The common practice of outdoor feeding has been too frequently to throw everything on the ground. Unfortunately, the ground surface will work up like a mud puddle through the continued trampling of the stock, and much food is either completely lost or very much soiled. Those farmers and swine-feeders who have practised feeding on a cement or on a tight wood plank platform obtain full use of the feed given, while those who persist in feeding on the frozen or semi-liquid mud of the feed lot or barnyard, suffer losses that run into hundreds of dollars each year.

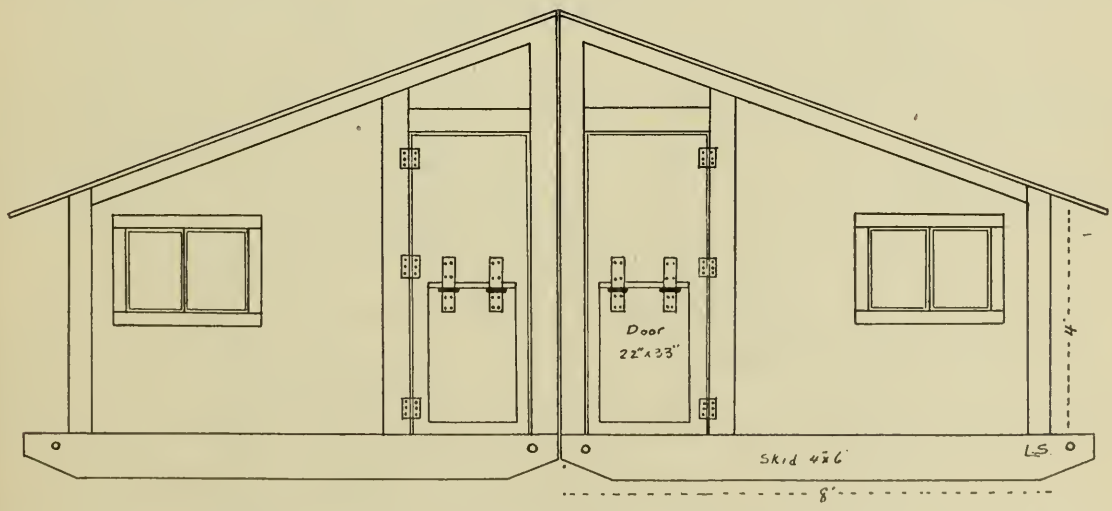
A cement feeding platform located handy to the feed storage and winter site of the Colony houses can be constructed at little cost by the ordinary farm help. A feeding platform should provide 10 square feet of space for each pig; it should be level and bounded by a small curb that is high enough to prevent



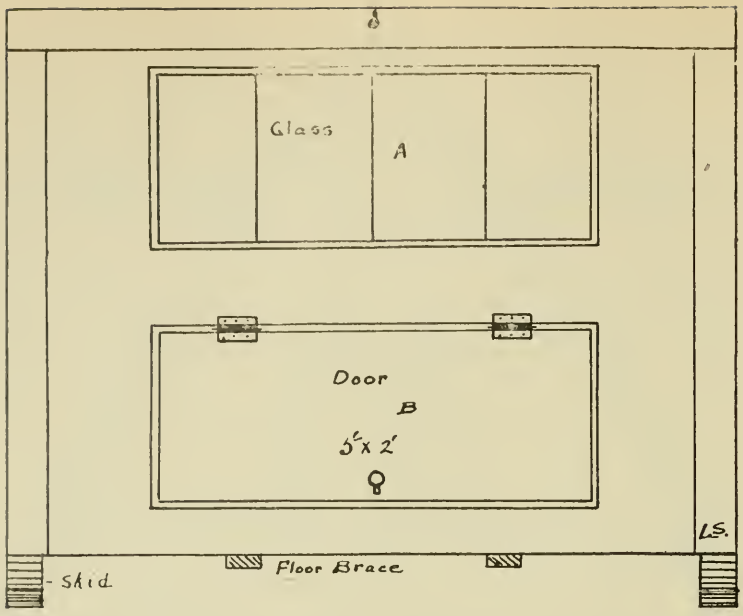
Colony House C.—Front elevation. A shape Colony House 8ft. x 8ft.; one entrance door and one window; side doors open for air, these can be thrown right up if desired. Narrow houses of this type can be built with one vertical side. This is an advantage as it permits two houses being placed close up for protection in cold weather. Houses of this type require a stiff frame of 2in. x 4in. well braced; if intended for summer use only single board and batten fills the requirement. Houses of this type can be buried in the straw pile for additional protection in winter. A stub wall 12 inches high on the sides makes a house less likely to be injured by rubbing than the house shown in the cut.

the feed being thrown off by the swine. A curb two inches high is usually satisfactory. The top surface should be six inches above the surrounding ground surface and all the area about should be well drained.

The permanent feeding floor can be constructed by staking out an area of the desired size and shape, using 2 in. by 2 in., or 2 in. by 4 in. stakes. Obtain the level for the corner stakes and then nail on the boards that form the mould and keep the cement in place until hardened. The tops should be levelled and the boards nailed and braced strongly in place. A large portion of the interior can be filled in with field stone and gravel. After this is done, a cement coating,



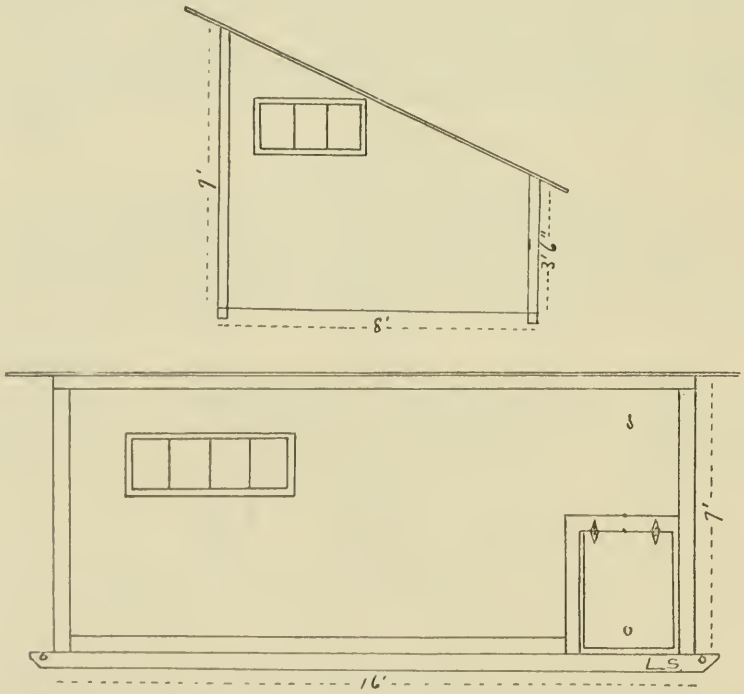
Colony House D.—Side elevation. The shed roof houses can be set together, four in a close group, no projection of roof at eaves, lower half of door to swing. Four Colony houses 8ft. x 8ft. can be grouped to form one house 16ft. x 16ft. for winter use. Individual houses of this type make excellent farrowing pens for both winter and summer use. This house is built 4 feet at back and 7 feet high in front. The swing section of door is 33 inches high by 22 inches wide. Rear and front wall ventilating doors 2ft. x 5ft.



Colony House D.—Front elevation. The shed roof house built without eave projection—front elevation—Window A may be removed where not needed. Sunshade door B open during summer and removed during winter if a number of houses are grouped to make a larger house. The no-eave feature permits houses to move up close together for winter use.

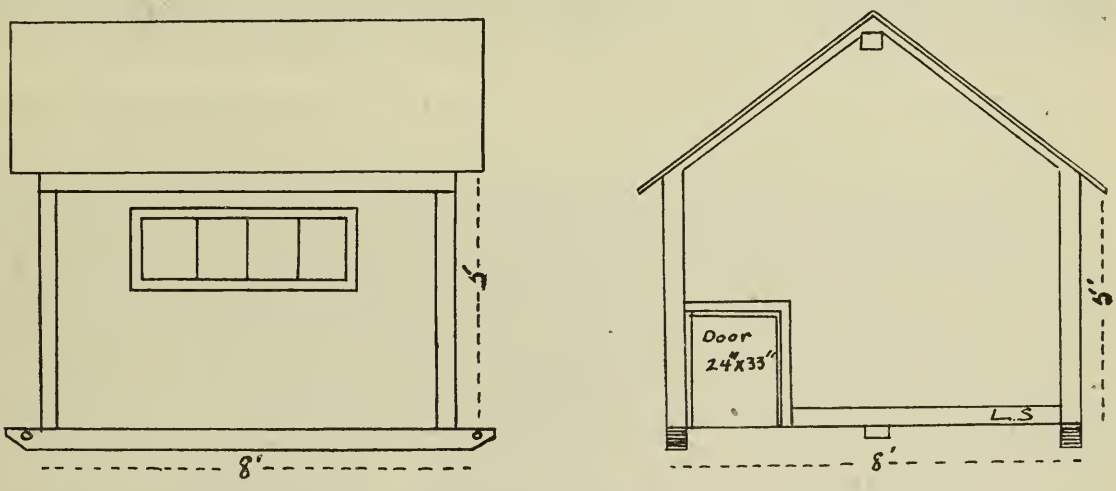
four inches thick, is laid on and planed down smooth, filling the entire form up to one-half inch of the desired level. The final or top half-inch, a rich mixture, one to one, is laid on and troweled down smooth. It is important that the surface be hard and smooth. The platform should be constructed at least a month before it is required, in order that it may harden well before being used.

Feeding platforms constructed of timber frame and planking are serviceable for a time, but the cost of timber is high when compared with the everlasting cement. The use of lumber is questionable other than for the portable feeding floor. The wooden feeding floor is best constructed by securing five 4 in. by 6 in.



Colony House E. Shed roof type of Colony House built 8 feet wide and 16 feet long will accommodate 6 brood sows during the winter period up to one month of the date of farrowing. A door for this type of house can be placed in the end instead of the side if it is desired.

timbers as long as it is desired to make the platform; sixteen feet is a very good length. These timbers are laid parallel about 4 feet centre to centre apart; bricks, cement bricks or flat stones should be placed on the soil for the timbers to rest on. An end piece 2 in. by 6 in. is spiked across each end and the entire framework braced. Planking 2 in. by 10 in. is used to floor the structure. Full length plank should be used, sixteen feet long, if the platform is to be sixteen feet wide, and so forth. The planks are held in place by using a 2 in. by 4 in. at each side and nailing every fourth plank at the ends only. By using the 2 in. by 4 in. on the ends of the planks but very little nailing will be required to hold the platform together. Should cracks develop, draw the few nails and crowd the planks up close together and then re-nail. If planks become warped the entire surface can be covered over with galvanized sheet iron, the edges of which must be well nailed down; or inch lumber can be used if put on to run in the same direction as the planking.



Colony House F. Side and end view of a very good house for a brood sow. Can be built warm enough to farrow in. Eight feet by eight feet with five-foot wall. Peak of roof can be slatted off and filled with straw. A small ventilator should be placed at either end in peak of gable.

Material required for cement platform, 20 ft. by 20 ft., with surface 6 in. above ground level:—

4 pieces 2″ x 8″ x 20′ for form making.
44 " 2″ x 2″ x 18″ for stakes
3 yards small field stone
3 yards gravel
3 " sand
30 sacks cement

Material required for wooden platform, 16 ft. by 16 ft., with surface 10 in. above ground level:—

5 pieces 4″ x 6″ x 16′ for sills or sleepers
2 " 2″ x 6″ x 16′ to bind ends of sleepers
25 cement block-tile or brick for sills to rest on
20 pieces 2″ x 16″ x 16′ for flooring
4 " 2″ x 4″ x 16′ to bind ends of flooring

Size of Colony Houses

Size is a very important consideration in Colony house building. Some authorities recommend a very small house, six feet wide, and eight feet long. This is a very good dimension for a house to be occupied by a litter of young pigs after weaning, or by a small sow and her family during fine weather, but it has been proven to be too small for a large sow and her litter.

The difference in cost between a house with a 6 ft. by 8 ft. floor space and a house 7 ft. by 9 ft., or 8 ft. by 8 ft., or 8 ft. by 10 ft., is so little that a larger house than 6 ft. by 8 ft. is recommended. The height of the Colony house wall should be at least 30 inches, where a peak roof type of building is planned. A wall 36 inches high will give more head room; it will also increase the air space and improve ventilation.

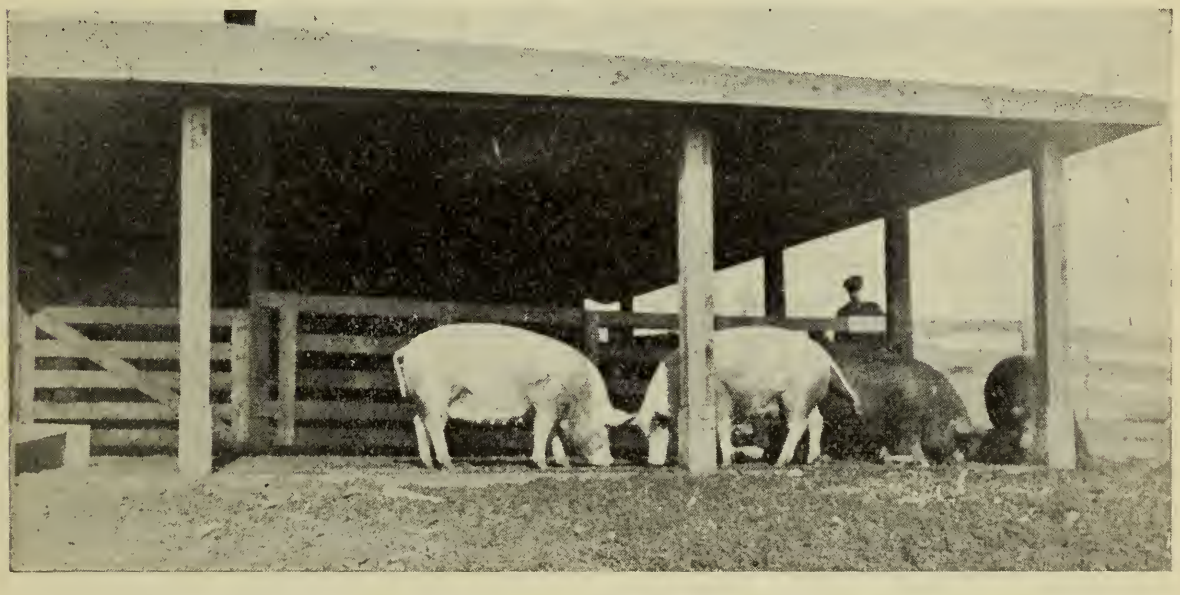
The open-door feature in the roof is an aid to cleaning out the pens, removing litter or working with the pigs. Glass sash can be set in for winter use if desired.

A Winter scene. This sow is quite content farrowed in February when the temperature was below zero, and raised a family of eight.

The large doors, open in the period of warm weather, provide shade and aid in making the house comfortable and sanitary. Note the portable fence and corn crib in background.

EXPERIMENTAL STATION, RIDGETOWN, ONT.

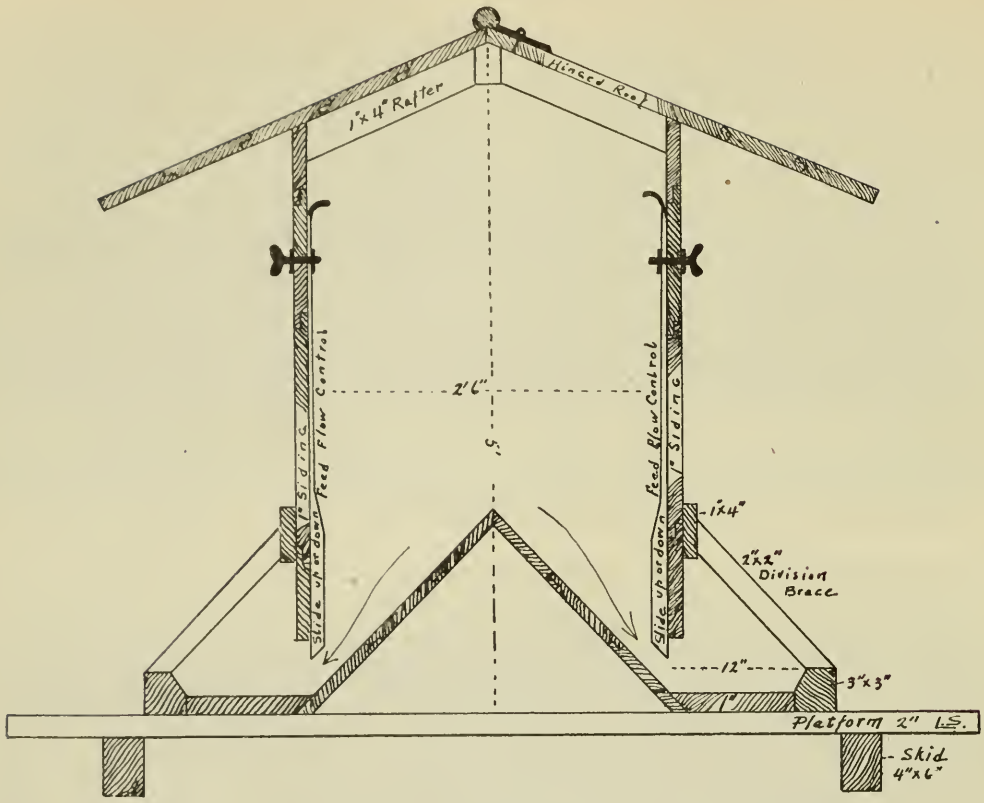
Feeding Shed surrounded by yard made of portable hurdles. A Colony House in each yard. All yards run up to and include a portion of the cement feeding floor.



Young sows feeding on cement floor. Corner of Feeding Shed.

Close up view of Feeding Shed and yard. All fences are portable, moved away in the Spring, the ground plowed and crop planted.

The Self-Feeder



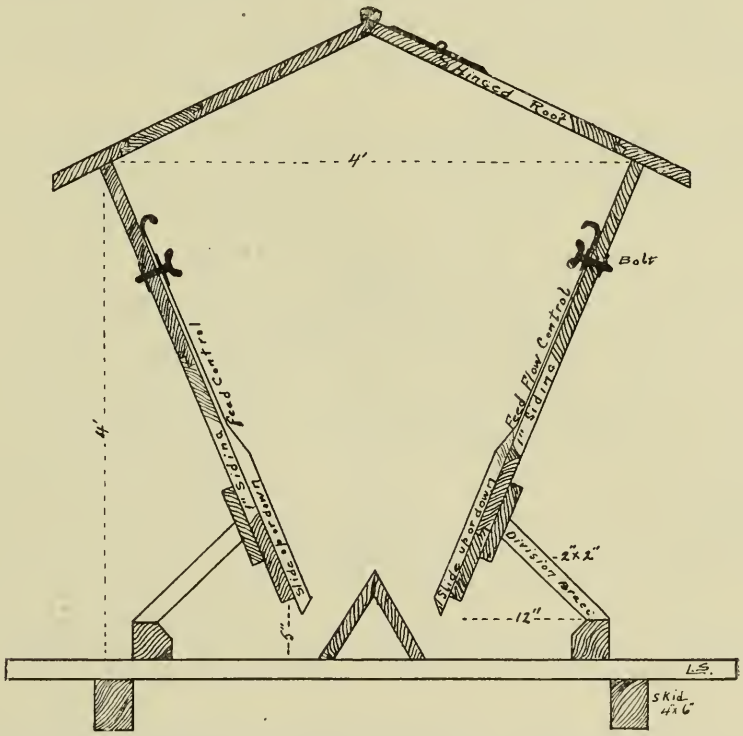
Self-Feeder cross section. Feed slide for each division to regulate feed flow if more than one kind of feed is to be used. The Self-Feeder should be placed on a platform or skid to make moving easy and prevent waste. Division braces should be placed every 15 inches.

The experience of the past ten years has greatly increased the popularity of the self-feeder, or "help yourself" type of feeding swine that are running in clover or grass pasture. By this system, the pigs are allowed to eat without any restraint, taking sufficient to satisfy of the various food in quantity to suit their own taste. The self-feeder is a feed box built with sloping sides, divided into a number of compartments and so arranged that the feeds are gradually released from the lower cavity as the feed is taken by the pigs. The removal of feed permits more to fall within reach of the pig. The self-feeder saves labour and overcomes in a large measure the evils of the often too careless hired man.

Self-feeders are placed in the feed lots in a position handy to get to, that such may be easily refilled and watched. There is a danger in the use of a self-feeder with very young pigs. The young or weanling pig is very apt to eat too much dry grain and become foundered, a condition that removes all chance of profitable development for the individual. If the self-feeder is to be used with weanling pigs, an abundant supply of milk should be provided at frequent intervals and the meal mixture blended to suit the needs of the very young pig.

Experiments have shown that pigs having access to self-feeders grow evenly, each pig getting what he needs. In trough or hand feeding, the big pig gets more than a fair share. With the grain feed always available, pigs will eat more per day, grow faster, and finish better than pigs trusted to the care of the average farm hand. The self-feeder saves labour and it is on duty Sundays and holidays, days when pigs on some farms are apt to be neglected. The clover or grass pasture is a part of the self-feeder game that must not be neglected. The summer feed to be profitable should be made of half and half clover and grain.

Young pigs having access to a self-feeder may neglect the pasture portion of their ration, so must be watched from time to time. The self-feeder can be used with mature breeding stock, providing the ration given is bulky and contains such roughage as ground alfalfa. Mature breeding stock are apt to become too fat if given the freedom of helping themselves. The self-feeder is intended as an aid to feeding operations during the grazing season, and as such, it will reduce the labour requirement of feeding over fifty per cent.



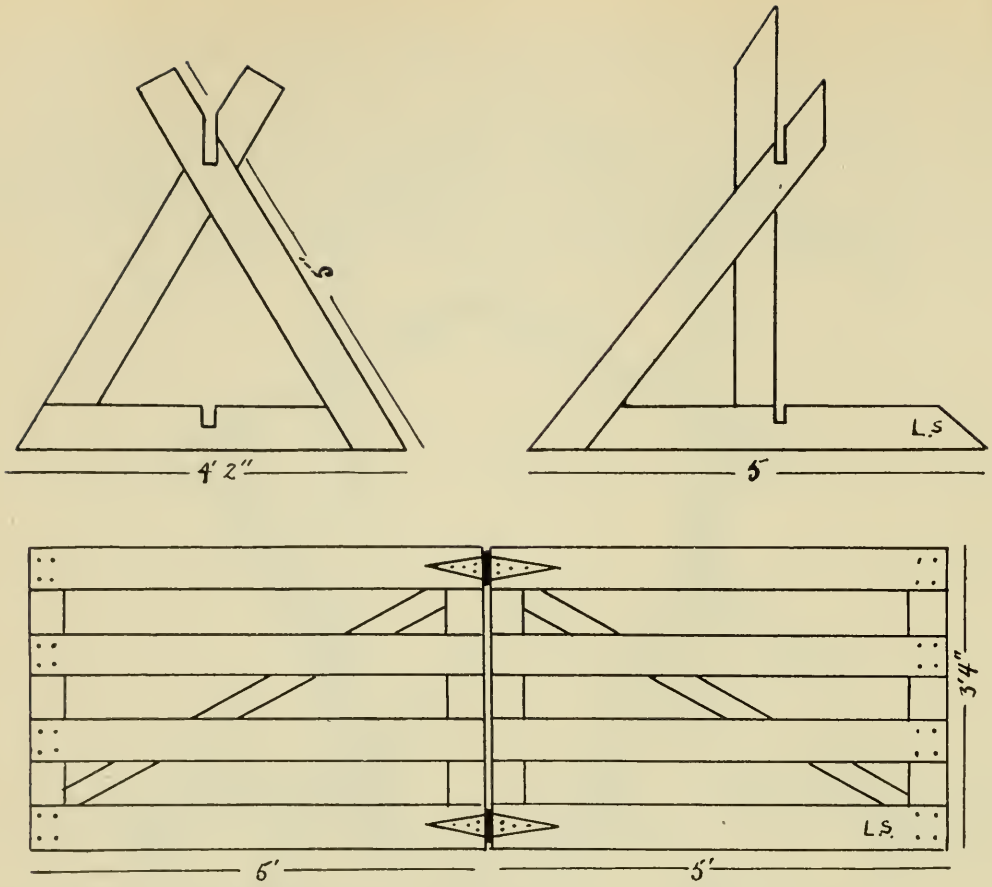
Self-Feeder cross section. Feeders are generally built six feet long in one compartment if but one feed or feed mixture is to be used. Feeders can be built any length and with as many sections as desired for various feeds, mixtures or conditioners.

The Brood Sow and the Colony House

Nearly every pig owner has learned the lesson that follows the practice of close confinement of breeding stock. Losses have been heavy, and experience dictates that satisfactory reproduction can only be accomplished where sufficient physical exercise is taken by the breeding stock. Exercise that will keep every organ in the animal body properly functioning is what is required. The brood sows quartered in a Colony house have to get out several times a day to feed and hustle around to keep warm. The fact that the sows can get out into the open air when so inclined is a very important feature of Colony house life. Outdoor exercise with abundant fresh air means vigor, while close indoor confinement with the dampness and foul air, usually results in putting the brood sows in a condition of body sluggishness that is later reflected in weak or lost offspring.

A small house for each family is certainly to be desired during the nursing period with young pigs. Such gives quietness, prevents family rows, insures proper feeding, gets the family used to the home that they may occupy during the season, and makes weaning easy by simply cutting out the sow.

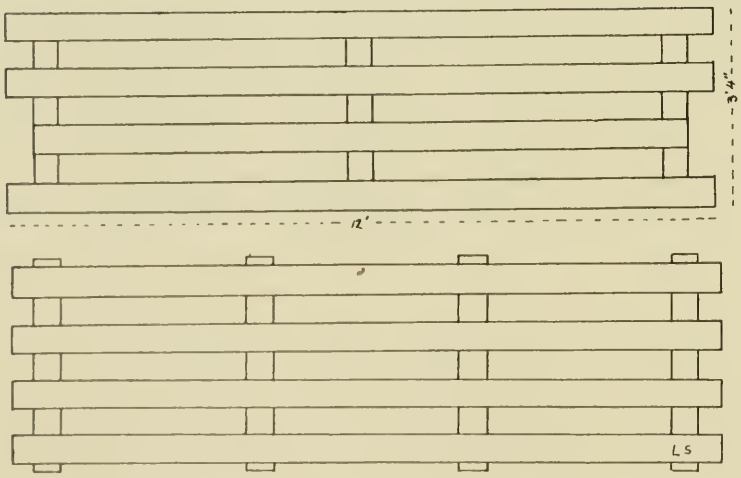
Sows well advanced towards farrowing should be given a Colony house or pen all to themselves a month previous to the expected date of increase. If the weather is very cold at the time the young are expected to arrive, an ordinary oal oil lantern in good condition hung from the ceiling and out of reach will give sufficient heat to take the chill off the air until the young pigs are twenty-



Two types of hurdles. Brackets in which hurdles may be set in building; portable fence for pig yards. Hinged hurdle useful in making a small corner pen.

four hours old. A protection rail should be put in position in the house a week ahead of time and left until the little pigs are strong enough to take care of themselves. In very cold districts, the Colony houses may be buried in a straw pile.

The Colony house of approved design gives good shade during the warm summer period. This matter of shade is very important and the Colony house is justified for this purpose, even if it could not be used for anything else, in that it gives comfort and prevents injury through blistering and cracking. Many of the Government farms and swine breeders at large now handle their brood sows entirely under the Colony house system.



Hurdles for swine yards are necessary in a Colony house system with frequent changing of location. Hurdles can be shifted and reset on short notice. Good spruce 1in. x 6in. lumber in the rough is the most satisfactory material for hurdles. Hurdles should be given a coat of green shingle stain for appearance and preservation.

Material Required for Portable Wood Platform—12′ x 12′

2 pieces 4″ x 6″ x 14′ for skids or runners
4 " 2″ x 4″ x 12′ for floor stiffeners
12 " 2″ x 10″ x 12′ for flooring
4 " 2″ x 4″ x 12′ to edge or curb.

The runners should be set eight feet apart and the flooring laid across and spiked. Floor stiffeners of 2 in. by 4 in. are used at the edges and between the runners. Inch holes are bored through the ends of the skids to accommodate clevis or pin to facilitate quick hitching on and moving from place to place as required.

Lumber Requirements for Colony House A or B Built 8′ x 8′ x 3′

2 pieces 4″ x 6″ x 9′ for runners
2 " 2″ x 4″ x 9′ stiffeners for floor
10 " 2″ x 10″ x 8′ plank flooring
4 " 2″ x 4″ x 8′ sills
2 " 2″ x 4″ x 8′ plates
2 " 2″ x 4″ x 12′ studs, sides
2 " 2″ x 4″ x 12′ studs, ends
5 " 2″ x 4″ x 10′ rafters
4 " 2″ x 4″ x 10′ door and window frames
250 board feet, 1″ x 10″, for wall covering and doors
85 lineal feet 1″ x 4″ trim
150 " " 1″ x 3″ battens

If double board and paper structure desired order 500 board feet 1″ x 10″ instead of 250 as for single.

Roofing for 200 square feet
2 pairs hinges for side doors
2 " draw bolts
1 " hinges for front swing door
5 hooks and rings
1 four glass sash, either 2′ x 2′ or 1′ x 4′
10 pounds of nails, and 3 quarts of oil stain.

For houses of B type, 3 pairs of heavy hinges and 2 hooks and staples are also required.

Lumber Requirement for Colony House C.

2 pieces 4″ x 6″ x 9′ for runners
2 " 2″ x 4″ x 9′ stiffeners for floor
10 " 2″ x 10″ x 8′ plank flooring
4 " 2″ x 4″ x 8′ sills
10 " 2″ x 4″ x 7′ side frame
4 " 2″ x 4″ x 10′ end frame
2 " 2″ x 4″ x 10′ braces
225 board feet, 1″ x 10″ covering boards
300 lineal feet 1″ x 3″ batten
100 " " 1″ x 4″ trim
30 " " 1″ x 6″ for doors
2 pairs heavy hinges for side doors
1 pair swing hinges for front door
5 draw bolts, 5 rings and hooks
10 pounds nails
3 quarts oil stain

Lumber Requirement for Colony House D, Built 8′ x 8′ Floor, 4′ 7′ at eave

2 pieces 4″ x 6″ x 9′ runners
2 " 2″ x 4″ x 9′ stiffeners for floors
10 " 2″ x 10″ x 8′ plank for floor
4 " 2″ x 4″ x 8′ sills
2 " 2″ x 4″ x 8′ plates
10 " 2″ x 4″ x 10′ studs
5 " 2″ x 4″ x 9′ rafters
320 board feet 1″ x 10″ siding for 1 layer
640 " " for double construction
225 lineal feet 1″ x 3″ batten
125 " " 1″ x 4″ trim

90 square feet prepared roofing
1 sash 2′ x 4′ glazed
1 " 5′ x 2′ glazed
4 pairs hinges for doors
1 pair swing hinges
2 hooks and rings
4 draw bolts
10 pounds nails
1 gallon oil stain

Keep Colony House and its Occupants Free from Vermin

Vermin cause considerable annoyance to swine and their presence in large numbers is destructive to profits. If the swine have a good wallow hole, they can free themselves of the pest during the summer, but without the assistance of a wallow, some other aid must be given or the lice will flourish. The pigs will be annoyed and the fences and pens racked through the rubbing of the swine in their attempt to free themselves from their tormentors.

The application of crude oil to the pig's skin will make the lice let go. The crude oil may be applied through the use of rubbing-post, equipped to deliver oil when the pigs rubs against it, or it may be applied with an oil can in the hands of a handy man. If an oil can is used, the spout is drawn along the pig's back from the ears to the tail and sufficient oil released to moisten the pig's skin all over. A good time to apply oil is when the pigs are standing at the feed trough.

Colony houses should be well sprayed with a two per cent. solution of creolin in the autumn and again in the spring.

Corrective for Winter Use

The use of a suitable corrective is strongly recommended by all successful swine feeders. One that is low in cost and fully efficient, and easy to prepare may be provided as follows:—

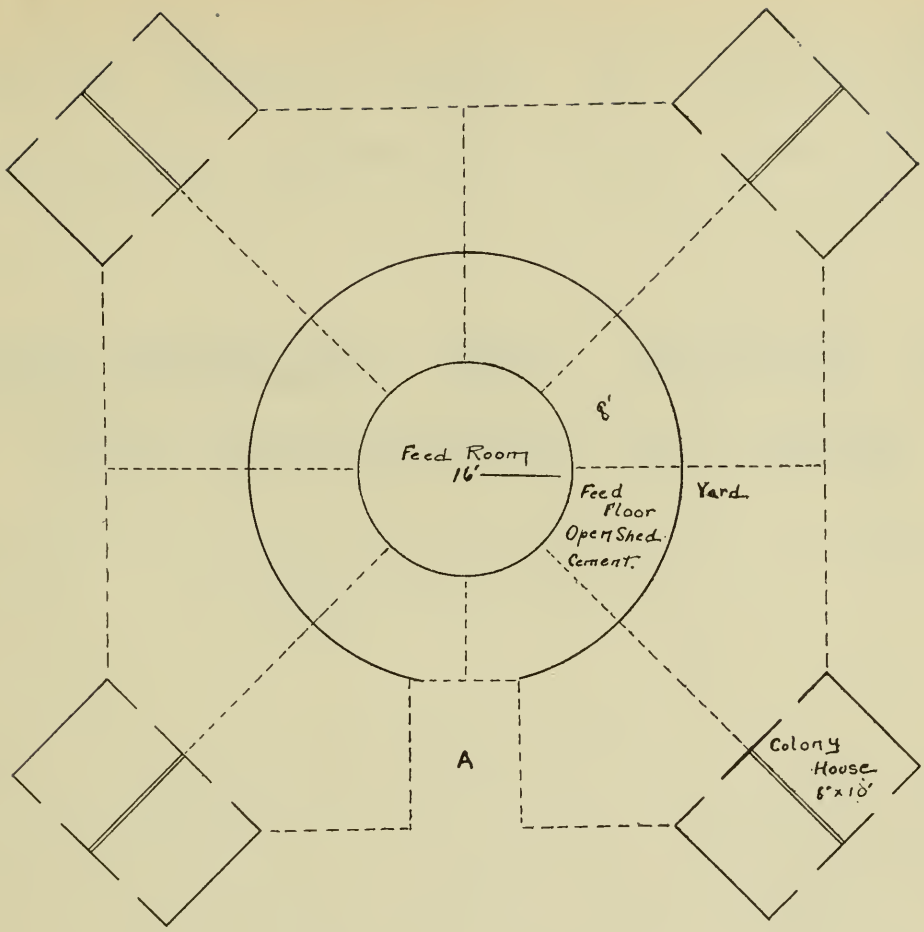
100 pounds of ground lime stone or slacked lime.
100 pounds of hard wood ashes or root cellar soil to which 10 pounds of bone flour has been added.
200 pounds of charcoal
50 pounds of salt
20 pounds of sulphur
2 pounds of iron sulphate

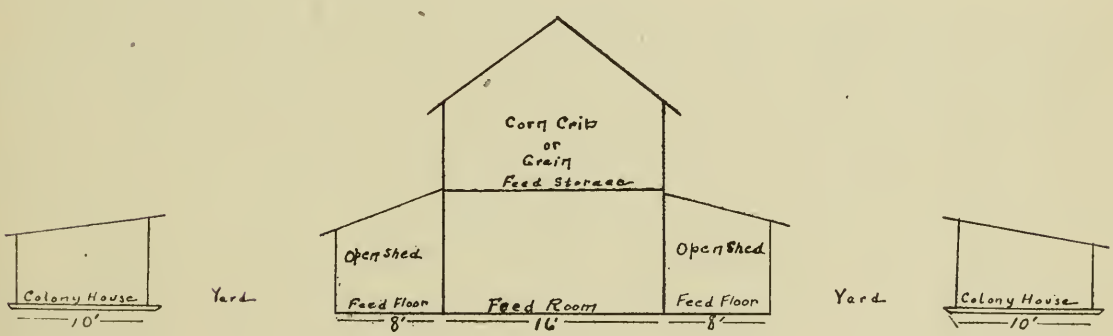
Mix all the dry material together excepting the iron sulphate. When all are mixed, dissolve the iron sulphate in a gallon of hot water, and sprinkle over the entire mass. Shovel over a few times and then store in sacks or barrels for use as wanted.

Pigs should be given free access to a feeder of box containing the above mixture.

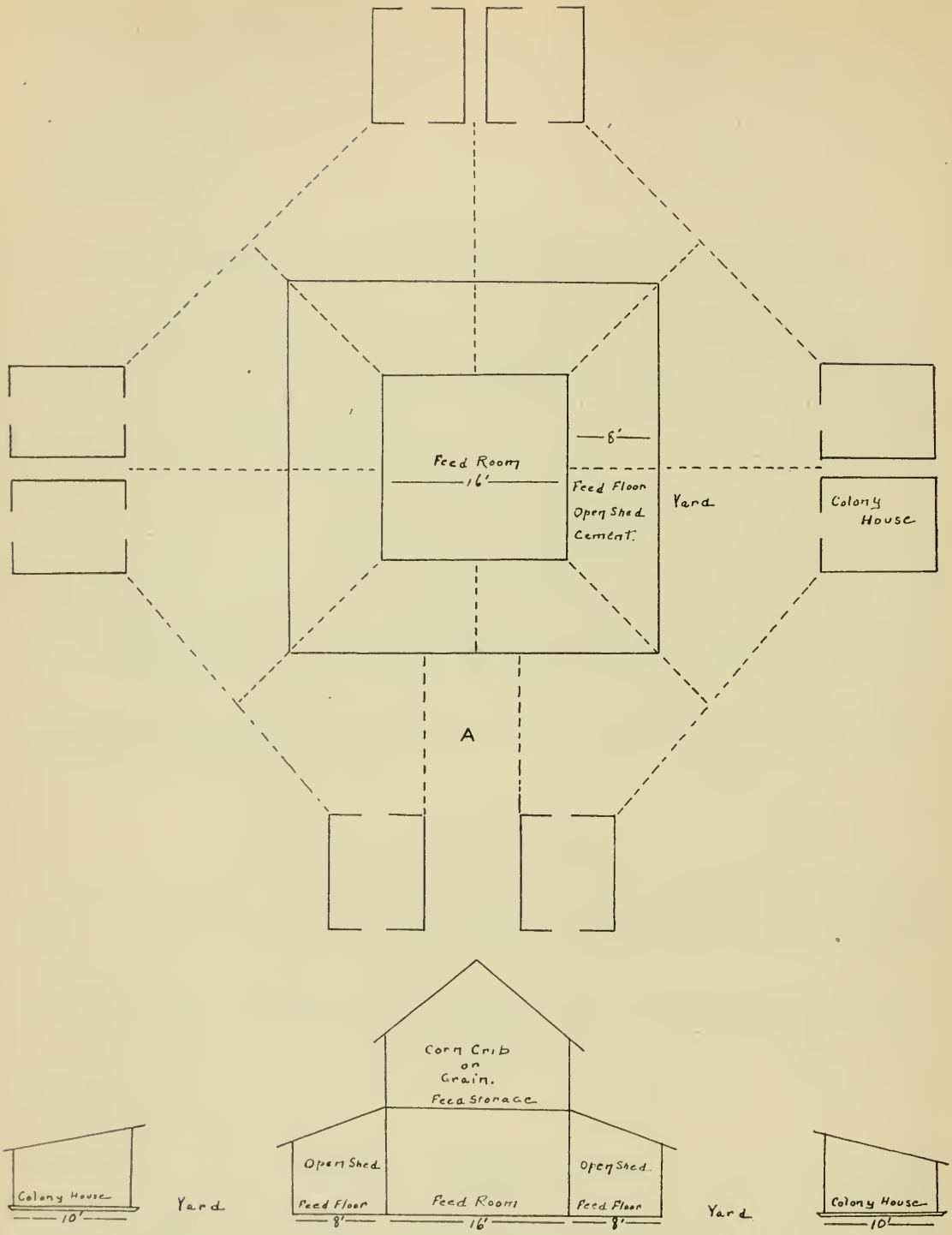
Swine are profitable when given abundant sunshine and exercise, fed on well selected feeds, gently handled, given proper sanitation and housing, kept free from worms and lice, and protected against cholera and other diseases. Quite a lot can happen a pig between birth and old age, but it is an easy animal to keep in the straight and narrow path leading to successful and profitable development if you go the right way about it.

Pigs frequently suffer more from the heat of the sun during the summer than they do from the cold of the winter period. If possible, make full use of any available shade trees when making your plans for swine pastures, feed lots or colony house locations.





Suggested layout where a circular feeding shed is used with Colony Houses; applicable to the corn belt, Southwestern Ontario. Hurdles used for yard divisions and feeding floor divisions. Feeding space for each pen 8 feet wide. The feed storage room and feed alley occupy 16 feet. The open space A permits delivery of feed to feed room.



Suggested layout for extensive Colony House shelter when used for stock hogs or feeders during the winter period. Applicable to the corn belt in Southwestern Ontario. Hurdles for yard divisions. More houses could be grouped on three sides and one side of Feeding Shed left clear as practised at the Experimental Station, Ridgetown.

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Ontario Department of Agriculture
ONTARIO AGRICULTURAL COLLEGE

PRELIMINARY SOIL SURVEY OF SOUTHWESTERN ONTARIO

By Prof. R. Harcourt, W. L. Iveson and C. A. Cline,
Department of Chemistry

INTRODUCTION.

Few people realize that the study of soils is a very complex subject. This is abundantly evidenced by the questions that are asked about the hundreds of samples of soils that are sent to us each year, and by the answers we are expected to give without seeing a sample or knowing anything of the previous manuring or cropping, the nature of the subsoil, or even the crops that are to be grown. Our inability to deal with these questions in a satisfactory manner led us to undertake a survey of the soils of the Province in order that we might get a proper perspective of the whole subject.

It is known that the soils are formed from the weathering of rock, and that different kinds of rock of widely different composition have been the source of our soils. Glaciers have shoved and carried these materials in certain directions; and later, water has further sorted the finer and coarser parts, giving us clays, loams and sands, some of which have been derived from one class of material and some from others. This difference in origin becomes a factor in classification. Because of these widely varying conditions the clay may be deep in some places, or it may be overlaid with sand or gravel in others, or the reverse condition may obtain, where we have sand overlaid by clay. On the other hand, we may have all the materials left unsorted, as in the morainal soils. These varying conditions not only affect the composition of the resulting soil, but, what is of equal importance, the aeration and drainage.

A study of these and other factors forms the first steps in a soil survey. Naturally a detailed study of the geology of the Province must be associated with the examination of the soils in their position. This necessitates going over the whole area and making frequent borings to locate the margins of the various series and types of soils and then charting these findings on a map of the Province.

VALUE OF A SURVEY.

The soil survey provides a complete inventory of our soils, and should bear the same relation to our soil resources that a geological survey bears to our mineral resources. Both are fundamental to the future development of the country.

In the past much of the value of fertilizer experiments has been lost, or at least misleading, because the results obtained on one kind of soil were not applicable to another. This is only to be expected considering the wide differences in composition and texture. Particularly is this true in Ontario with reference to the application of lime. In fact, in all fertility and crop production investigational work, we at the College would find the soil maps of inestimable value because, knowing the soils of each county, as shown on the maps, we could be of more service to the farmer.

The survey is also of value to farmers looking for a new location, and for city folks who want to buy land for specialized crops. It will have especial value to immigrants. Copies could be available at our Immigration Offices. Land appraisers and bankers making farm loans can use the soil surveys in determining land values.

High Schools and Colleges giving instruction in agriculture can use the soils surveys in dealing with soil and crop problems. Agricultural Representatives, the Underdrainage Department, and Farm Economics Department, and Extension Specialists will find constant use for the information in the Soil Survey maps and reports.

In the United States, where much soil survey work has been done, road engineers use the soil maps in locating roads and in finding suitable road material. Various manufacturing industries, such as canners, makers of clay products and cement, find the surveys useful in selecting locations for factories. The soil maps indicate deposits of materials of industrial importance, such as gravel, sand, shale, tile, brick and potting clays, limestone and marl.

Another use that is being made of the soil surveys in the United States is in connection with the large life insurance companies. They make use of these maps in making public health and sanitary surveys. They find there is a direct correlation between the health and wellbeing of the people of particular communities and the character of the soil. Often they are able to say, "On such a soil you will find such a degree of comfort and progress." This is of great value to them.

HOW THE SURVEY IS MADE.

This work may be done in two ways. By a preliminary or reconnaissance survey, or by a detail survey.

In the Preliminary Survey the soil men go up and down about every other concession road or side line, to get a broad general idea of the larger and more important soil areas. It is a preliminary investigation to find out what series of soils exist and to roughly chart out their areas. No attempt is made to show minor variations. The travelling is done by motor car with frequent stops to make borings where change of soil is indicated.

The Detail Survey is made by the soil men walking over every part of the land in order that they may detect all minor changes in the soil. Naturally this method is much more thorough, and, of necessity, much slower; but where the soil types are mixed and the farming consequently diversified, it is the more valuable. Yet some preliminary survey must precede the detail survey in order that it may be known what soil series and types there are in the Province.

In the Detail Survey two men work together. With a soil auger they examine the surface and subsoil to a depth of 40 inches. In some cases deeper borings are made. Observations of road and railway cuttings or other means

available are made use of in gaining a knowledge of the subsoil. Representative samples of each type are collected and sent to the laboratory for analysis.

A full report of a Detail Survey thus gives, in addition to the soil map, a description of the properties and chemical composition of the soil and subsoil, topography, water supply and drainage conditions, crop adaptation, general fertility, systems of farming and methods of soil management. There is also included in the report a description of farm improvements, important products, markets, transportation facilities and the general condition of the community.

It is granted that a report of a Preliminary Survey cannot be of much practical use to the average farmer. Its great value lies in the fact that it forms the basis for a practical systematic study of soil problems.

Plot experimental work on cultural methods and with fertilizers can then be established on the larger types of soil. Following up our Preliminary Survey we have established three experimental or demonstration plots on three widely different types of soil. Considerable other experimental work with fertilizers has been carried on where the type of soil under investigation has been kept in mind. This follow-up work will be of immediate practical interest to every farmer.

This report deals only with the Preliminary Survey, and the accompanying map shows only the great soil series. Some detail work has been done and many samples of soil from different Series and Types have been analyzed, but the discussion of the results will be reserved for another publication.

COMMENCEMENT OF THE WORK.

A start was made on our preliminary survey in 1914 by the late A. J. Galbraith. He continued the work in 1915 but made slow progress as the work was new to him. During the summers of 1916 and 1917 Mr. Woodward carried on the survey and considerable progress was made. But in 1918 another change had to be made, and the late W. L. Iveson, who had been more or less in touch with the work throughout the previous three years, took charge. He reviewed much of the earlier work and completed the mapping of the area east as far as Kingston. East of this point the soils are so diversified that little headway can be made on a reconnaissance survey. Nearly all of one season was spent in a somewhat semi-detail study of the soils of Dundas County and part of Russell and Carleton Counties, which will be discussed in a separate publication. Unfortunately, Mr. Iveson died suddenly early in the winter of 1920 before his field work was fully recorded.

During the summers of 1920 and 1921 no attempt was made to carry on survey work, as we could not procure a suitably trained man, and our energies were devoted to establishing the demonstration plots and conducting special fertilizer tests on the mapped areas. In the meantime we selected one of our own men and had him trained for the work.

In the latter part of the summer of 1922 a start was made on a Detail Survey of the soils of Kent County, and about 100 square miles were mapped.

THE AREA SURVEYED

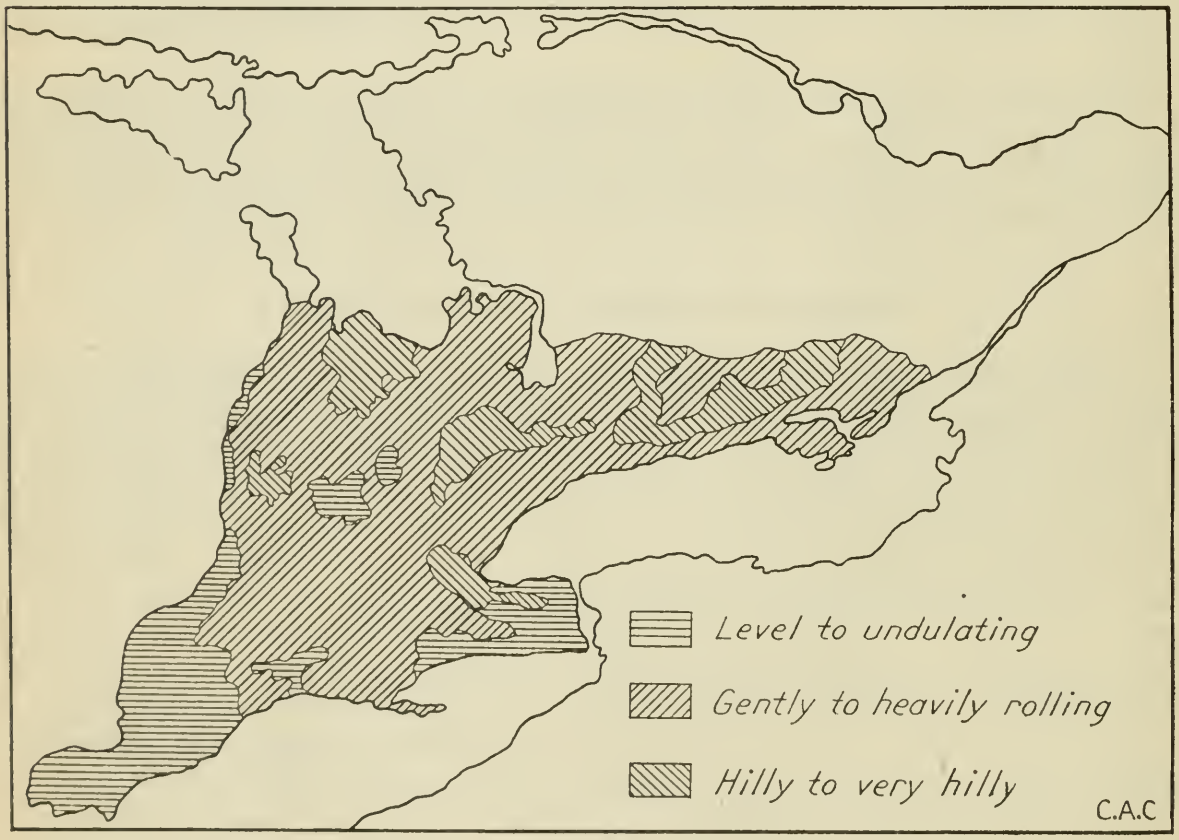
Location and Extent.—The area surveyed which is to be discussed in this publication includes that part of Ontario lying west of Kingston on the Albemarle-Amabel town line, an irregular line extending southeast from Sturgeon

Bay to Kingston. The most northern part, Nottawasaga Bay and Sturgeon Bay, extends a little above 44° 50′ north latitude, while the southern extremity at Pelee Point is a little below 42° north latitude, making nearly three degrees of latitude between the northern and southern borders. The extreme distance from east to west is a little over six and one-half degrees of longitude, extending from a little less than 76° 30′ west longitude, at Kingston the eastern boundary, to a little over 83° at Detroit River, the western boundary.

PHYSICAL FEATURES

Altitude.—The surface of southwestern and central Ontario varies in elevation from 245 feet above sea level along the shores of Lake Ontario, to 1,700 feet or a little higher in the neighbourhood of Dundalk. This makes an extreme range of about 1,450 feet. Only a small area, which extends along

TOPOGRAPHICAL MAP OF SOUTH WESTERN ONTARIO



both shores of Lake Ontario, is below 400 feet; east of Trenton this area is usually twelve to sixteen miles wide, but farther west it is narrower, ranging from one or two miles to six or eight miles wide. Another small area, which extends from Orangeville Junction northward past Shelburne and Dundalk and culminates in a high promontory, called "the mountain", just west of Collingwood, rises above 1,600 feet. Dundalk is 1,700 feet above sea level and several points on the mountain are nearly as high. Other points in that section may be a little higher. On the east and north of this high area there is an abrupt descent, but to the south and west the surface slopes gradually toward Lake Erie and Lake Huron.

Topography.—The topography of this area has been influenced to a large extent by the glaciers which covered all of southwestern and central Ontario

and by the waters of the glacial lakes which covered a large part of this area during the recession of the ice. Some pre-glacial and inter-glacial valleys, among which may be mentioned those occupied by the Bighead, Beaver and Pine Rivers, may have been deepened and widened to some extent by ice erosion, but most of them have been partially or entirely filled by glacial drift. In general the ice plowed down ridges and made the surface less rugged, but it also left large deposits in the form of terminal moraines, some of which are quite steep and hilly. Material, deposited in the beds of streams flowing through crevices in the ice, remained after the ice melted, as long, narrow ridges. Past glacial erosion has been active where there has been considerable fall. This is especially noticeable along the Bayfield, Maitland and Saugeen Rivers. In these sections, however, erosion has only extended a short distance back from the streams. Wind action has also been active in some sections, causing the formation of sand dunes, as seen in Norfolk, Simcoe and Prince Edward counties.

Between the steep eroded hillside and the poorly-drained level areas, there is a great variation in topography. As the lay of the land is of considerable importance in deciding what type of farming is most profitable, it seemed desirable to show the more important differences in topography, as well as the different soil types, on the map. This has been done by means of cross-lining. The topography has been divided into four classes and indicated on the map by parallel lines running in different directions. (See map of Topography.)

Class I includes poorly-drained, flat to gently undulating areas. On a large part of these areas, artificial drainage is necessary before they can be successfully cultivated. These areas are shown by horizontal rulings.

Class II includes areas that are gently rolling to hilly. Practically all of this class has good surface drainage and with a few exceptions the surface is not steep enough to interfere with cultivation. This class is shown by northeast-southwest rulings.

Class III includes areas that are hilly to very steep and broken. In practically all of this class the slopes are steep enough to interfere with cultivation. A large part should not be cultivated at all but, instead, should be used for pasture or forestry. This class is shown by northwest-southeast rulings.

There is very little of Class IV either in southwestern or in central Ontario, and some of the areas that were found are so narrow that they could not be shown on the map. This class is very steep and broken. It is found mainly along escarpments where the descent is very abrupt.

All classes necessarily include small areas of others. In some sections there are areas of two or more classes that are too small to indicate separately. These are grouped together and shown as the class that has the greatest area. In other areas the surface was near the dividing line between two classes and it was difficult to determine what class to place them in. In spite of these difficulties, however, the cross-lining indicates fairly well the character of the land surface.

Moraines.—A study of the map will show a large body of the rough hilly land (Classes III and IV) in the northern and central parts of Grey County. This section is near Georgian Bay, and on account of the high elevation above that body of water, was badly eroded before the advent of the glacier. As the glacial stream had a tendency to follow the depressions, it did not cover this high land so soon or remain so long as on the lower country to the east, west and south. Consequently the preglacial features were modified to a less extent, and, in addition, some of the preglacial valleys were eroded still further by the ice and many rough morainal ridges were formed. These moraines

are only a part of the terminal moraines of southwestern Ontario. (See map of Moraines.) From this section strong moraines, known as the Goderich, Wyoming and Seaforth moraines, stretch away to the southwest through the southeast corner of Bruce and on into Huron County, continuing as far as Wyoming and the St. Clair River. Below Clinton, however, the relief is not great. Between Hanover and Teeswater, the moraine is strong, but most of the slopes are long and not steep enough to interfere with cultivation, so this section is included in Class II. There are, however, some steep slopes along some of the streams which flow in preglacial valleys. These valleys are deep canyons, but they are so narrow that they could not be shown on the map, so they are included in Class II. From Teeswater to Clinton there is a considerable area of rough steep land which is shown as Class III. Just north of Wingham the country is so rough and hilly that it is known as the "Alps."

Beginning in eastern Grey County, two strong moraines known as the Paris and Galt moraines, extend southward across eastern Dufferin County, the northwest corners of Peel and Halton Counties, eastern Wellington County, and Southern Waterloo County, continuing as far south as Galt and Paris. A small area of rough hilly land is found along the Waterloo moraine, which extends from a point west of Waterloo to a point south of Galt.

The Oak Ridges moraine, which extends from southeast Dufferin County across York, Durham and Northumberland County, is one of the strongest moraines in southeast and central Ontario. The greater part of this moraine is very rough and hilly. In York and Ontario Counties the rough hilly land occupies a rather narrow strip, but in Durham County it is much wider, and in Northumberland County it occupies almost the whole of the southeast part.

North of Barrie, in Simcoe County, there is another region of strong ice action. This area, which is small but very rough, is partly kame formation. In Bruce County between Southampton and Shallow Lake, the Port Elgin moraine is steep and rugged, forming a small area of rough land.

Along the north side of Niagara Peninsula there is a narrower steep bluff. This bluff, which marks the boundary between the hard resistant Niagara limestone and the softer shales of the Medina and Cataract formations, is known as the Niagara Escarpment. It follows the south shore of Lake Ontario to Hamilton, then turns northward to Inglewood, where it is buried by morainal deposits. It appears again a few miles west of Alliston and continues in a general northwesterly direction to "the mountain" near Collingwood.

There are a few places along the lake shores, particularly along Lake Huron, where the sand deposited by the waves has been blown into dunes. These dune areas are rough and hilly, but they are less extensive than the dune areas found along the Oak Ridges moraine.

South of the rough, hilly area in Grey County, and between the Paris and Galt moraines on the east and the Seaforth and Wyoming moraines in the west, there is an undulating to gently rolling plain. The northeastern part of this plain has an elevation of 1,600 to 1,700 feet above sea level, but there is a gradual slope towards Lake Erie on the south and Lake Huron and Lake St. Clair on the west. A large part of this plain was covered by the waters of the glacial lakes. (See map of Ontario Island.) In most places there is no marked change in topography at the line of division between the "Lake Plain" and the "Upland Plain." The former, however, has a larger area of flat land than the latter. The upland has some flat areas, particularly on the divide in southeastern Grey, northeastern Wellington, and western Dufferin Counties. A large number of these lime areas are swampy, and form the headwaters of many of

the streams flowing south and west. A number of long narrow ridges are found in this section. The material in these ridges or eskers was deposited in the beds of streams flowing through crevasses in the ice. Some areas of rolling country are found in the "Lake Bed," particularly where the elevation above the present lakes has favoured erosion.

FACTORS INFLUENCING DEPOSITION OF SOILS

Glacial lake waters covered a large part of Simcoe County and a small area south and east of Lake Simcoe in York and Ontario Counties. The greater part of these areas are level to gently rolling but there is a large area just south of Sturgeon Bay that is very rough and hilly. In this area the material seems to have been deposited, for the most part, in cavities within the ice and then covered with water from the retreat of the ice. Stratified material is frequently encountered in cuts along the roads but this material is often covered by bouldery material. Lake action modified the surface by removing material from hills and depositing it in the valleys.

There is a narrow strip of lake plain along the north shore of Lake Ontario. West of Scarborough there is a gradual rise from the "Lake Plain" to the Upland, but farther east there is an abrupt rise.

That part of the old lake bed which has been influenced most by the lake water includes all of Niagara peninsula south of the escarpment and extends along Lake Erie to the Detroit River, Lake St. Clair and the St. Clair River. This was the first part of Ontario covered by lake waters, and this is where most of the large glacial streams deposited their sediments and accounts for their high fertility. A number of water laid moraines give some relief and there has been a limited amount of stream erosion. The greater part of the area, however, is level to undulating. Practically all of Essex, the greater part of Kent and Lambton and a considerable area in Welland and Haldimand Counties is flat and poorly drained. Quite a large area in northern Essex County is only a little higher than Lake St. Clair. The only way that a large part of this area can be drained is by pumping the water from the drainage canals into the lake.

Although there are a few flat areas in that part of the old lake bed bordering on Lake Huron, the greater part of the surface is rolling. In this section the ice remained for a longer period than further south and fewer large streams deposited sediments in this area. Consequently the topography has been only slightly influenced by the lake waters. There is also considerable fall and erosion is more active than along Lake Erie. Small areas of badly eroded land are found along the Bayfield, Maitland and Saugeen Rivers.

Regional Drainage.—The greater part of Ontario drains westward and southward into Lake Huron, Lake St. Clair, and Lake Erie. This is due to the height of land which extends from "the mountain" southward, passing east of Dundalk, west of Shelburne and Orangeville and east of Guelph and Galt. As already mentioned, a large part of the country to the west of this divide is undulating to rolling, with a gradual descent to the west and south. Nearly all the large streams in southwestern Ontario have their origin in this section. The direction in which they flow is determined by slight irregularities of the surface.

Another sharp divide is found extending east from southwestern Dufferin County across north Peel and central York, central Ontario, central Durham and central Northumberland Counties. Streams rising to the north of this

divide flow into Georgian Bay and Lake Simcoe, Lake Scugog and the lakes of the Trent Valley system, while those rising to the south flow into Lake Ontario.

CLIMATE.

Temperature.—Plant growth is influenced by climate as well as soil, but, while the farmer can modify the soil to a certain extent, he cannot change the climate. However, some knowledge of the climate is necessary in order to determine what crops are best adapted to a particular section. In Ontario, corn is a good illustration of this fact. In the southwestern counties of Essex, Kent and Lambton, seed corn is grown successfully. In nearly all other sections, the season is not long enough for this crop to mature, so it is grown only for silage. The chief factors which influence the distribution of crops are temperature, precipitation and sunshine.

The mean annual temperature in southwestern and Central cntario varied from 41° F. at Coldwater in Simcoe County to 46° F. at Cottam in Essex County. The average mean annual temperature for the entire section is 44° F. In some periods of years January is the coldest month; in others February. In a few places, March is nearly as cold as December, while in most places it is considerably warmer. July is the hottest month, but there are a few places where the mean monthly temperature of August closely approaches that of July. Very high summer temperatures and very low winter temperatures have occurred. Temperatures of 100° F. or over and also of —30° F. or lower have been reported.

From an Agricultural standpoint, the mean monthly and annual temperatures and the maximum and minimum temperatures are of less importance than the length of the growing season or the number of days between the last killing frost in the Spring, and the first killing frost in the Fall. In southwestern and central Ontario the average date of the last killing frost in the Spring falls on May 14th. The earliest is May 3rd at Kingston and the latest May 29th at Alton. The average date of the first killing frost in the Fall varies from September 16th at Alton to October 18th at Hamilton and Windsor. The length of the growing season varies from 110 days at Alton to 169 days at Hamilton and Windsor.

The data in the following table has been summarized from the records of the Ontario Meteorological Bureau; years 1893–1913.

LENGTH OF GROWING SEASON.

District.	Late Frost.	Early Frost.	Growing Season.
Agincourt, Port Hope, Uxbridge	May 18th.	Sept. 29th.	134 days
Hamilton, Toronto, Stony Creek, Welland	May 5th.	Oct. 11th.	159 "
Port Dover, Port Stanley, Chatham, Windsor	May 9th.	Oct. 9th.	153 "
Paris, Guelph, London, Brantford, Woodstock	May 17th.	Sept. 26th.	132 "
Stratford, Clinton, Listowel, Lucknow, Lindsay, Orillia	May 20th.	Sept. 24th.	127 "
Goderich, Kincardine, Southampton	May 14th.	Oct. 10th.	149 "
Collingwood, Meaford, Owen Sound	May 13th.	Oct. 6th.	146 "

The chief factors which influence the length of the growing season are nearness to large bodies of water, latitude, and elevation. The influence of large bodies of water is shown by a comparison of the data from inland points such as Stratford, Clinton, etc., and Kincardine and Goderich. At the former points the growing season is less than 130 days while it is over 145 days at the latter points. Inland points have frosts later in the Spring and earlier in the Fall. At Port Hope, however, the average date for early Fall frosts is September 27th, which is only three days later than at Durham, an inland point.

Altitude has some influence, as shown by a comparison of Alton, with an altitude of 1,250 feet and a growing period of 110 days, and Agincourt, with an altitude of 590 feet and a growing period of 142 days. This difference is only partly due to difference in elevation as Agincourt is near Lake Ontario and has undoubtedly been influenced to some extent by that body of water.

Precipitation.—The average annual precipitation in southwestern and central Ontario, based on twenty years' records (1893-1913), varies from 24.21 inches at Bloomfield in Prince Edward County to 41.27 inches at Woodstock in Oxford County. The average for 32 stations is 31.84 inches. There is no region that is unusually wet or dry. Marked variations are found at points only a few miles apart. Woodstock and Brantford are a few miles apart, yet, Brantford has 11.21 inches less rainfall than Woodstock. The same is true regarding the monthly precipitation. One place may have a high precipitation during a certain month and another place only a few miles away will have a low precipitation during the same month. As a general rule the precipitation is quite evenly distributed over the twelve months, yet, at certain places, the precipitation is unusually low or high during certain months.

Sunshine.—The annual total possible hours of sunshine for southwestern Ontario is 4,452 hours. The actual hours of sunshine in a certain district is expressed as a percentage of this total. This percentage varies for the different districts. While the possible sunshine is the same for all during a definite period, the sky is overcast by clouds more in some than in others. The lower the percentage the more hours of cloudy weather. In Ontario there is a gradation from 60 per cent., or 2,671 hours, at Windsor in the south to 38 per cent., or 1,815 hours, at Barrie in the north. Well marked belts receiving the same percentage of sunshine extend across the Province in the southwesterly direction. For instance, if a line be drawn through Kingston, Belleville, Cobourg, Stony Creek and Port Rowan, the records of the area south of this line show us that it receives 55 per cent. or more of the possible hours of sunshine during the period May to October. The Niagara Falls-Port Colborne District receives 60 per cent. or more, so also does the district west of the line Rondeau to Sandwich. Proceeding north from the lakes the percentage of sunshine decreases approximately five per cent. for every fifty miles to a certain point, then it increases. (See map.) Note the high percentage of sunshine in a portion of the Muskoka District, one of the recreation spots of Ontario. This doubtless helps to account for its popularity.

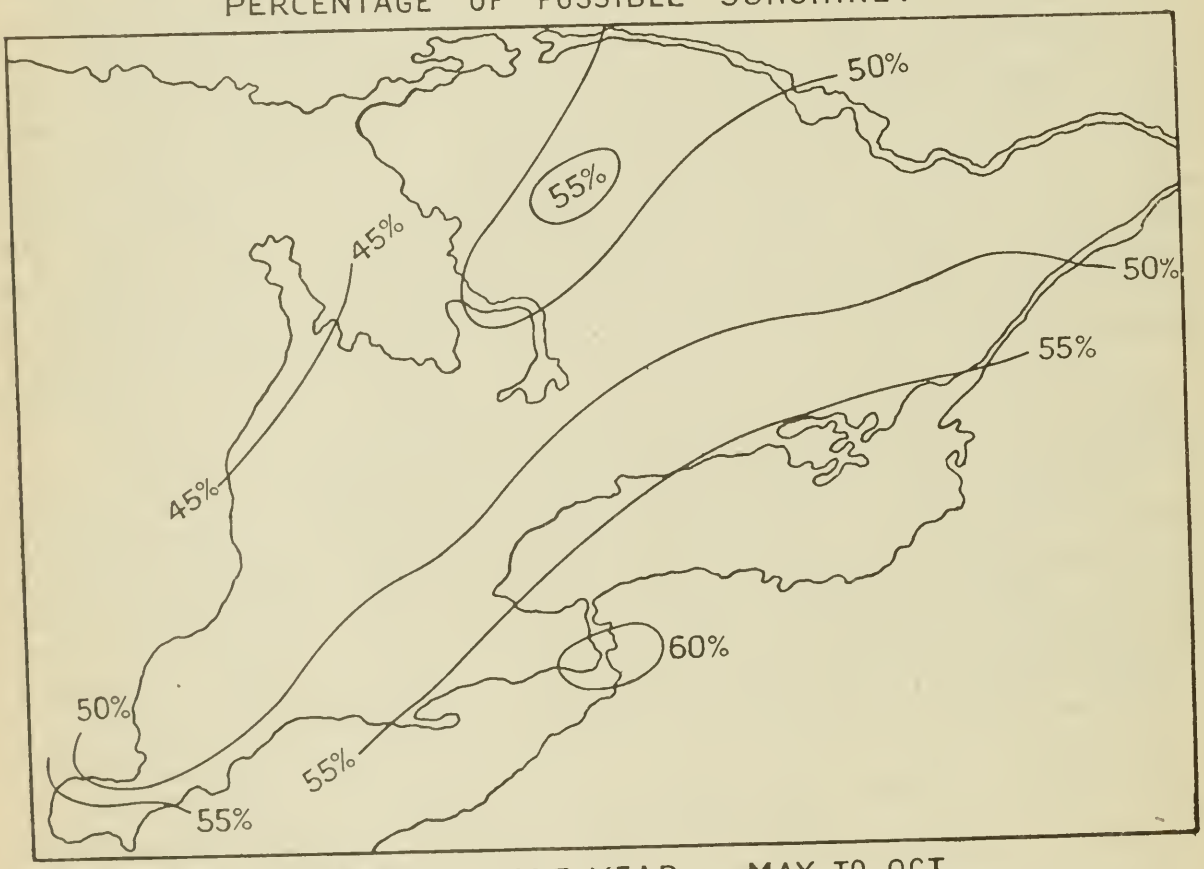
FORMATION OF SOILS.

Almost the entire land surface of the earth is covered by a layer of unconsolidated material which is known as "mantle rock" or "the regolith." This "mantle rock" has been formed by the disintegration and decomposition of the solid rock by atmospheric agencies, chiefly changes of temperature, and solution.

This action, which is known as weathering, removes a large amount of material, but, in most places, there is an accumulation of rock debris which is mixed with a varying amount of plant and animal remains. The surface layer of this material, where the decomposition of the organic matter and the weathering of the rock debris has produced conditions favourable for the growth of plants, is known as the soil. The term soil is applied to the surface layer, and subsoil to the material directly underneath. In humid regions there is usually a rather distinct line between the soil and subsoil, the former being darker in colour.

In southwestern and central Ontario, part of the soil material is granite fragments brought down from the Laurentian plateau by the glaciers. The greater part, however, came from the underlying rocks. These rocks are limestones, sandstones and shales. Marked differences are seen between soils

PERCENTAGE OF POSSIBLE SUNSHINE.



SUMMER HALF YEAR — MAY TO OCT.

Courtesy of Ontario Meteorlogical Bureau. Records 1893-1913.

derived from limestone material and those derived from sandstone and shale material. The greater part of this area is underlain by limestone and that rock forms the chief constituent in a correspondingly large proportion of the soils.

Marked differences are seen in soils formed under different conditions of moisture. Some were formed where there was thorough underdrainage as well as surface drainage; others where there was good surface drainage but poor underdrainage, and still others where surface and underdrainage were so poor that water stands on the surface most of the time. Soils showing all gradations from those formed under good drainage conditions to those formed under swamp conditions are found in southwestern and central Ontario.

Variations in texture are found ranging from dune sand to heavy clay. The greater part of the area has a medium texture, loams and clay loams predom-

inating. The clays are found where the surface was covered by glacial lakes. They represent sediments deposited in quiet water. Large areas of this type are found on Niagara peninsula and between the west end of Lake Erie and the southern end of Lake Huron. Some of the sand areas are morainal deposits reworked by the winds; others, delta deposits, and still others, shore-line deposits. Both the delta and shore-line deposits have been modified to some extent by the wind.

UNDERLYING GEOLOGICAL FORMATIONS OF OUR PRESENT SOILS.

The Niagara escarpment extends along the north side of the Niagara peninsula from Niagara River to Hamilton; then north and northwest to "the mountain" just west of Collingwood; then west to the city of Owen Sound; then north along the west side of Owen Sound; and then west along the south side of Colpoy's Bay. This escarpment was formed by the differential erosion of the hard resistant Niagara limestone and the softer Medina and Cataract shales and sandstones underlying it. This difference in erosion has left the Niagara formation standing in a steep bluff or cliff where it is not covered by glacial deposits. Along Georgian Bay there are two bluffs. The first, which borders the bay and has an elevation of 400 feet in some places, is formed from shales of the Cataract formation. Several miles farther back the Niagara limestone forms a second but lower cliff.

Nearly all of the area west and south of the Niagara escarpment is underlain by limestone and this rock has furnished the greater part of the soil material. Even in the small section where the underlying rock is shale, the rock is covered by sedimentary deposits which contain a large part of limestone material. On the other hand, glacial action has deposited sandstone and shale material over a small area of the limestone north of Hamilton.

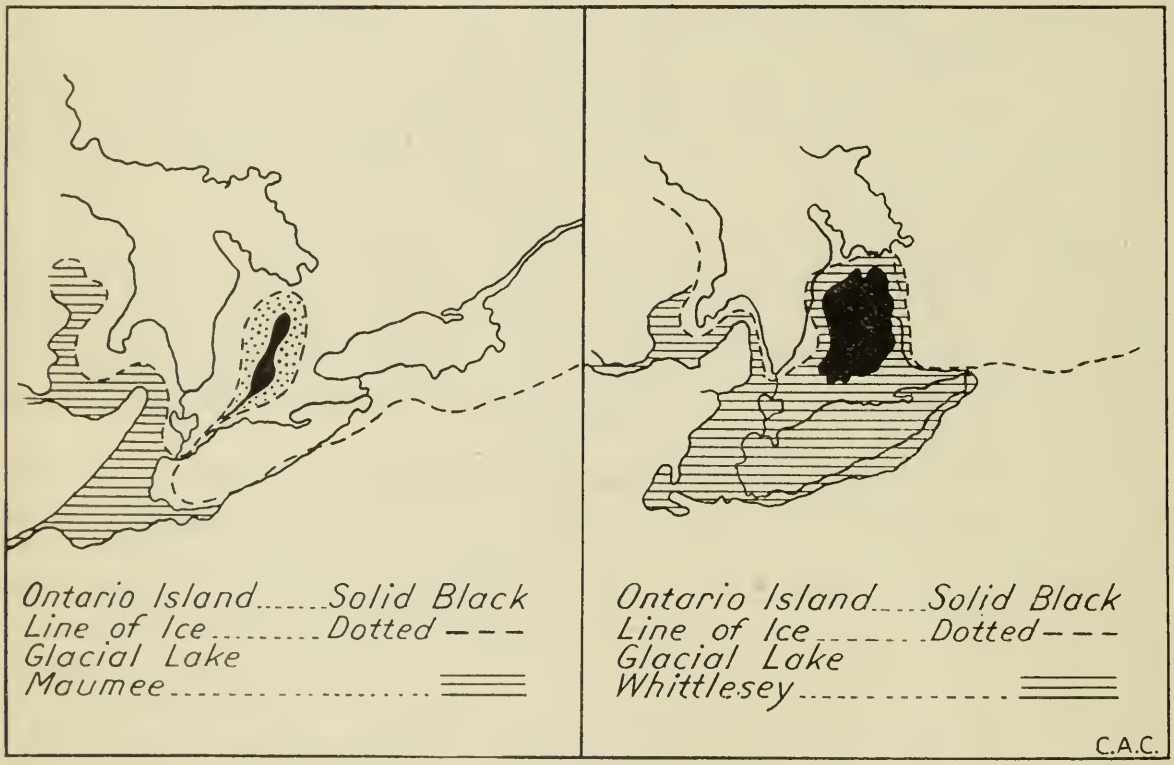
To the north and east of the Niagara escarpment and extending north to a line from Nottawasaga Bay to Lake Ontario near Oshawa, there are the Cataract, Hudson River, and Utica formations. Farther north and east, the Trenton limestone forms the country rock. In the southern part of this section, where the direction of the ice movement was from Lake Ontario inland, the soil material came from the underlying sandstones and shales. But farther north, where the direction of the ice movement was towards the south or southwest, a large part of the soil material is from the Trenton limestone lying to the north, making the soils similar to those in the areas which are underlain by limestone. A large part of the area of shale and sandstone rocks in Simcoe, Peel, York, and Ontario counties is covered by calcareous material and the soils derived from this material are typical limestone soils.

Emergence of the Highlands.—Taylor in his book on "The Moraines of Southwestern Ontario" gives an account of the emergence of the Highlands, what afterwards became known as "Ontario Island," which was the first part of Ontario to appear above the ice sheets. Because of its interest in connection with the soils of Ontario we quote from Taylor's book an account of the probable geological origin of this section of Ontario. "When the advancing ice sheet reached the high promontory west of Collingwood, its advance was retarded at this point but continued to the east and west in two mighty lobes which are known as the Erie, Ontario and the Huron lobes. In time, however, these two lobes coalesced, covering all of southwestern Ontario and extending on into New York, Ohio and Michigan."

"The highlands between Dundalk and 'the mountain' were probably covered to a depth of two thousand or three thousand feet, but the ice remained for only a comparatively short time. The first area uncovered, however, was not at this point but farther south. Here as the melting ice became thinner, it finally ceased to move. Rivers were formed which cut deep canyons in the ice. These streams gathered up large quantities of material from the dirty ice. A large part of this material was deposited either in the stream beds or in large cavities into which the streams sometimes emptied. These deposits remain, the former as long, narrow ridges known as eskers, and the latter as hills known as kames. In time the ice disappeared from a small area of land northeast of London. Although this area increased in size as more land was uncovered to the north, it was surrounded on all sides by ice for a long time and is known as 'Ontario Island.'

"During the warm season each year the ice sheet was affected by melting, not alone along its edge, but over a marginal belt several hundreds of miles wide.

EMERGENCE OF ONTARIO ISLAND



Adapted from Smithsonian Report 1912

It is to be remembered also that great ice streams like those which flowed past this island were hundreds of feet higher along the line of their central axes than at their sides. On this account, an extensive high obstruction in the path of the ice sheet, but over which the ice moved, always caused a depression in the surface of the ice sheet, and where the obstruction was so great as the highlands between Lake Ontario and Lake Huron, it formed a correspondingly large depression. The surface of the ice sheet for fifty to a hundred miles all around sloped toward this depression, and all the water from the melting on these slopes flowed into it. It is manifest that there was no chance for an outlet for this water anywhere north of London. But along a line running southwest from London, the ice of the Huron and Erie lobes met head on. This produced a deadline in the ice and a trough or crease in its surface. This crease led southwest from London to the edge of the ice sheet and was the only possible way of escape for the water

that flowed into the depression of 'Ontario Island.' Judged by its hydrographic basin, that river, which we may call the 'Crease River,' should have been a river of large size. It was the glacial precursor of the modern Thames river."

As the ice retreat was really a series of retreats and advances, each advance being less than the preceding retreat, the size of "Ontario Island" fluctuated from time to time. There were periods when the ice front remained in one place for a long time. The ice sheet was still advancing, but it was melting just as rapidly as it advanced, and so the edge of the glacier remained at the same place. As the ice melted it deposited its load of rock debris. Where the ice front remained in one place for some time, these deposits form terminal moraines which vary from low ridges to rough, steep hills. Terminal moraines were formed during periods of retreat as well as during periods of advances, but the former were obliterated when the ice advanced again. Material deposited between the terminal moraines is known as the ground moraine. In general, a ground moraine is less hilly and contains more fine particles than a terminal moraine. The morainal soils are characterized by the presence of unsorted materials varying in size from fine clay particles to large stones, e.g., Guelph stony loam. Occasionally, ground moraines include small areas of water-laid or sedimentary soils, such as Puslinch plains near Guelph. Terminal moraines were formed on both sides of "Ontario Island." These mark different stages in the retreat of the glacier. During the retreat of the glacier a strip of land appeared between the basins of Lake Simcoe and Lake Ontario. Several moraines were formed in this region. The most important of these is the Oak Ridges moraine, which extends from the Niagara escarpment as far east as Trenton. This is one of the strongest moraines in Ontario. (See map of Moraines.) This accounts for the hilly land a short distance north of Lake Ontario.

WATER-LAID OR SEDIMENTARY SOILS.

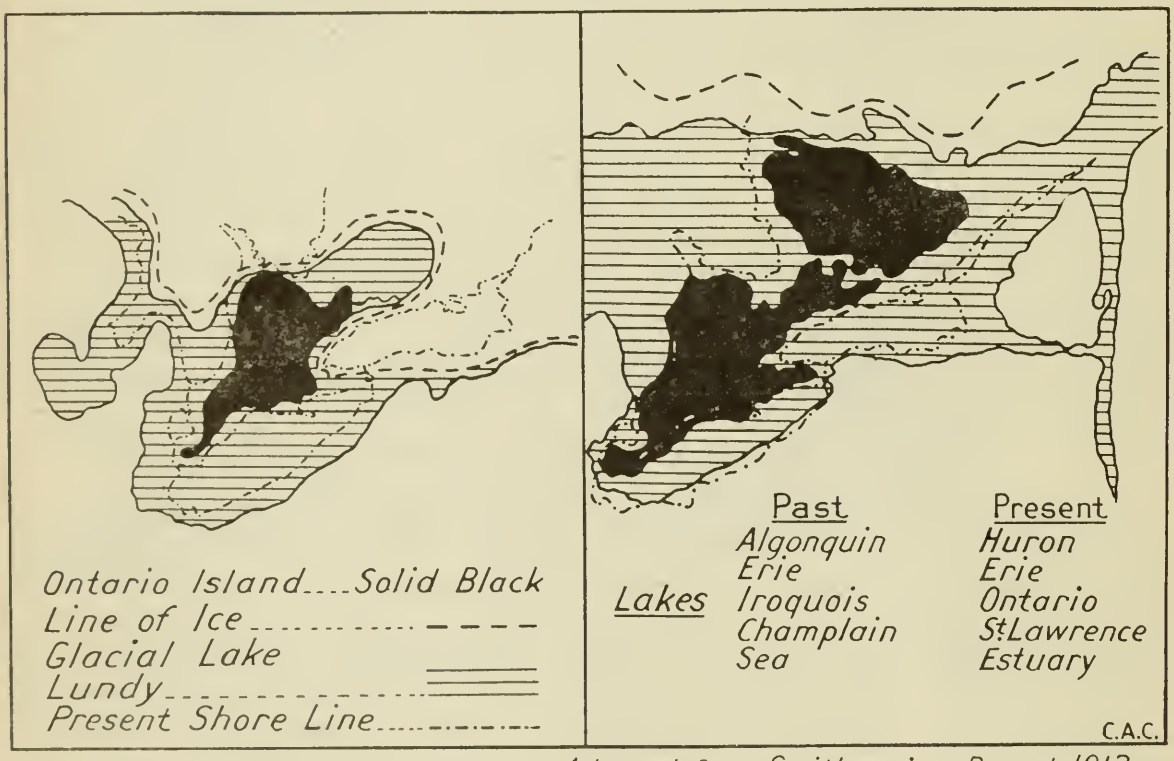
The water from the melting ice formed large lakes which changed their level as the retreat of the ice opened up new outlets. These lakes covered a large part of southwestern Ontario, including all the country from the Detroit River almost up to London; all of Niagara peninsula; a wide strip along the north shore of Lake Erie, and narrow strips along the east shore of Lake Huron and the north shore of Lake Ontario. Another area that was covered with lake waters lies between Georgian Bay and Lake Simcoe. These lakes received the waters from many large streams which were formed during the ice retreat. These streams carried vast quantities of material into the glacial lakes. The coarser particles settled near the mouths of the streams in the form of deltas, while the finer particles were carried farther away and settled in quiet water. These lacustrine or lake deposits give rise to soils having different characteristics from those derived from the glacial till of the uplands which were not laid down in water. As the former have been subjected to the sorting action of water, they have a wider variation in texture, all grades being found, from light sands to heavy clays. On the other hand, the glacial till soils are of medium texture, varying from sandy loam to clay loam. The lacustrine soils have been influenced less by the underlying rock. These two great divisions of soils form our two Soil Provinces. The areas are shown on the accompanying map.

In some sections the glacial till as well as the lacustrine deposits have been modified by wind action. Post-glacial streams are so young that their valleys are quite narrow. In some the stream occupies the full width of the valley. Others have small areas of bottom land but they are too small to indicate on the map so were not considered on the preliminary survey.

CLASSIFICATION.

Soil differences are due to two sets of factors, the character of the material out of which the soils were formed and the agencies which have changed that material from rock debris and inert plant and animal remains into a medium favourable for the growth of plants. The origin of the soil material, whether derived from crystalline rock limestone, or sandstone and shale, or a mixture of these, has an important influence on the character of the soil. The weathering of rock in place produced soils different from those formed by the weathering of glacial drift or sediments deposited in lakes or along streams. Glacial drift soils differ from lacustrine and river terrace soils. Soils formed under marsh conditions are markedly different from those formed under good drainage conditions. All of these factors must be considered in a soil survey as well as the variation in texture or difference in the size of particles.

GROWTH OF ONTARIO ISLAND



Adapted from Smithsonian Report 1912

Following the classification of the Bureau of Soils, United States Department of Agriculture, the soils of southwestern Ontario have been separated into provinces, groups, series and types.

A *Soil Province* is an area where there are similarities in the main agencies of accumulation. As previously shown, there are only two soil provinces found in southwestern Ontario, the Glacial and Loessal Province, and the Glacial Lake and River Terrace Province. The former province is divided into two groups, the one including soils derived from limestone material, and the other, soils derived from sandstone and shale material.

A *Soil Series* is a group of soils differing in texture but having all other characteristics similar. All soils within a series are similar in colour of surface and subsoil, origin of material from which they are derived, agencies by which this material was accumulated, and differences due to variations in the process of weathering since the material was deposited. Each series is given a name, which is usually that of a town or city, township, or county, e.g., Guelph, London

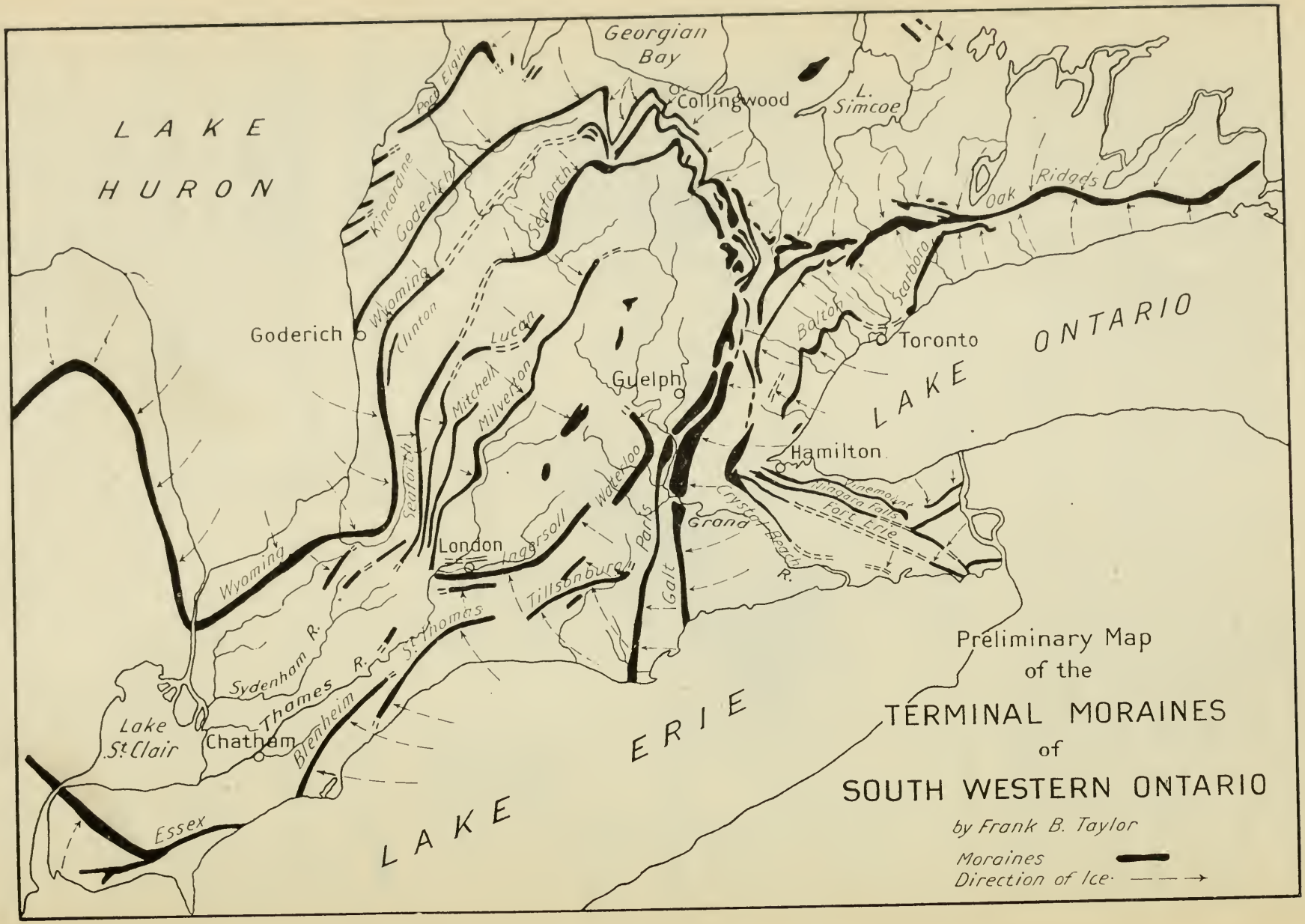
and Milton series, where one of the types within the series was first discovered. It is not a difficult matter to master this classification and be able to recognize the various series of soils.

A *Soil Type*, which is the soil unit, is a textural division within the series. All areas of soils uniform in all their characteristics are placed within the same type. According to texture, soils are divided into sands, fine sands, sandy loams, fine sandy loams, loams, silt loam, clay loam, silty clay loams and clays. The name of the soil type is the name of the textural division preceded by the name of the soil series in which it is found, e.g., Guelph sandy loam, Guelph loam, London clay loam, Clyde clay.

In the following table, the soils of southwestern and central Ontario, as found in the preliminary survey, are arranged according to province, group, series and type:—

CLASSIFICATION OF THE SOILS OF SOUTHWESTERN AND CENTRAL ONTARIO.

Province.	Group.	Series.	Type.
Glacial and Loessal Province	Glacial Limestone Group	Guelph Series	Guelph stony loam Guelph sandy loam Guelph loam
		London Series	London loam London silt loam London clay loam London silty clay loam
	Glacial Sand and Shale Group	Milton Series	Milton loam Milton clay loam Milton clay
		Lockport Series	Lockport clay
Glacial Lake and River Terrace Province	Glacial Lake Group	Dunkirk Series	Dunkirk sand Dunkirk sandy loam Dunkirk loam
		Haldimand Series	Haldimand clay loam Haldimand clay
		Clyde Series	Clyde sandy loam Clyde loam Clyde clay loam Clyde clay
		Warners Series	Warners loam
		Hastings Series	Hastings stony clay loam
Organic Soils			Muck and peat.

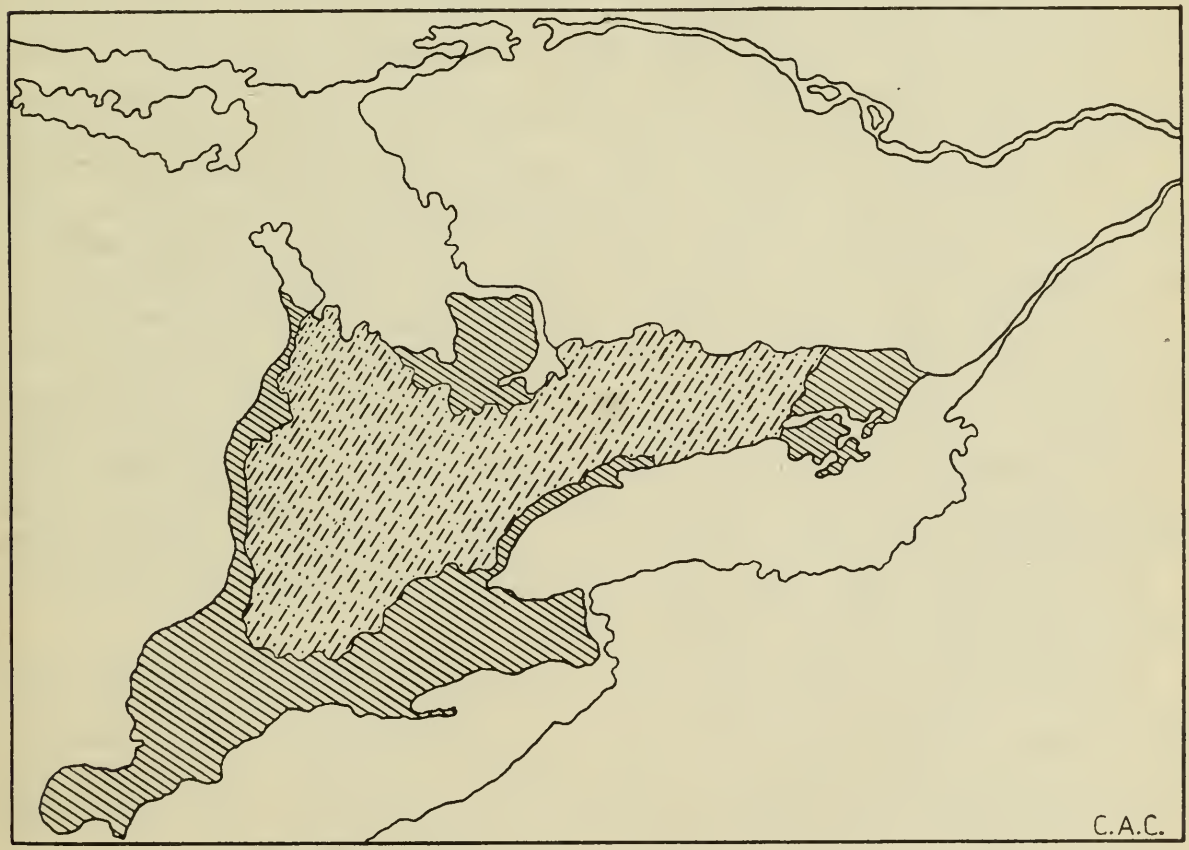

Preliminary Map
of the
TERMINAL MORAINES
of
SOUTH WESTERN ONTARIO
by Frank B. Taylor
Moraines
Direction of Ice
LAKE HURON
LAKE ONTARIO
LAKE ERIE
Georgian Bay
Collingwood
L. Simcoe
Goderich
Guelph
Toronto
Hamilton
London
Chatham
Lake St. Clair
Pard Elgin
Kincardine
Goderich
Wyoming
Clinton
Seaforth
Lucan
Mitchell
Milverton
Waterloo
Ingersoll
Tillsonburg
Paris
Galt
Grand R.
Crystal Beach
Niagara Falls
Vinemount
Fort Erie
Oak Ridgds
Scarboro
Baltor
Wyoming
Sydenham R.
Thames R.
St. Thomas
Blenheim
Essex

THE GLACIAL LIMESTONE GROUP.

(Guelph and London Series.)

The glacial limestone soils were formed by the weathering of ice-deposited calcareous material. The greater part of these soils is underlain by limestone and it is this underlying rock that has furnished most of the calcareous material which distinguishes these soils from other soils derived from ice-deposited material. There are, however, considerable areas where the underlying rock is shale and sandstone, but the soil was derived from calcareous material which was brought from a distance by the ice. In most places this calcareous material is

SOIL PROVINCES OF S.W. ONTARIO



Glacial Lake & River Terrace Province
Series – *Dunkirk, Haldimand, Clyde, Warner, Hastings.*

Glacial & Loessal Province
Series – *Guelph, Milton, London, Lockport.*

in the form of limestone fragments, but in northern Peel and in southern Simcoe counties there is an area where the soils contain a large amount of marl. At present there are large deposits of marl in Simcoe and in small lakes and marshes farther north. It is possible that similar deposits were formed in the same section during interglacial times, and that the advancing ice shoved this marly material before it and deposited it in the region previously mentioned.

The greater part of southwestern and central Ontario is covered by the glacial limestone soils. Only seven types were mapped but some of them are very extensive. These seven types are included in two series—the Guelph series and the London series.

GUELPH SERIES.

The Guelph series includes soils with reddish brown to chocolate brown surface soils and reddish brown to yellowish brown subsoils. In all the Guelph soils, gravel and small stones are found in the deeper subsoils, and, in many places, stratified sand and gravel. This coarse material in the subsoil gives excellent drainage and this has produced the rich brown colours of the Guelph soils.

Although the soils of the Guelph series are typical morainal soils, and are found on nearly all of the ice-laid terminal moraines in southwestern and central Ontario, they also occupy large inter-morainal areas, particularly in the northern and eastern parts of "Ontario island." It is probable that most of the material from which these soils were formed has been carried only a short distance from the places where the glacier picked it up. It is also likely that the greater part of the areas occupied by the Guelph soils is underlain by bed rock at a comparatively short distance below the surface. Small outcrops of bedrock were frequently observed, particularly in the Guelph stony loam. These outcrops are quite noticeable in northern Grey county and northwestern Wentworth county. In both sections there is a considerable area with the bedrock within three feet of the surface. These areas have the thorough drainage and rich brown colours of the Guelph soils and so they were included in that series.

The Guelph soils were formed by the weathering of glacial limestone drift under good drainage conditions. The material is practically the same as that from which the London soils were formed, but the latter soils were developed under poorer drainage conditions, which has produced soils with a lighter colour.

The surface of these soils varies from gently rolling to steep and hilly. The rougher topography is found along the stronger moraines and in places where rough preglacial topography has only been slightly modified by glacial action.

In this series three types were recognized, the Guelph stony loam, the Guelph sandy loam, and the Guelph loam.

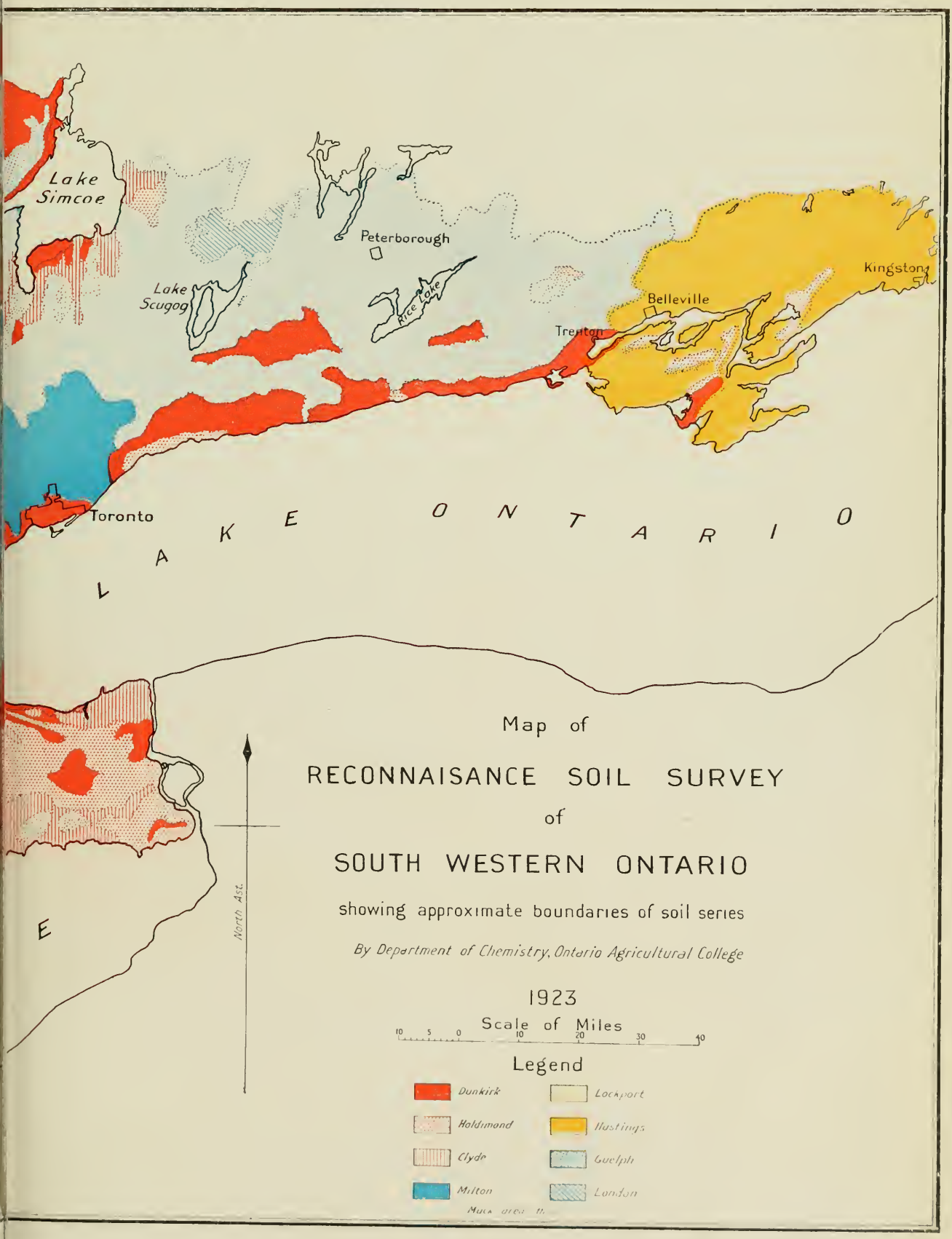
Guelph Stony Loam.—The main difference between the Guelph stony loam and other types in the Guelph series is the large amount of stones in the former type. These stones vary in size from small pebbles to huge boulders. There are places where there is a large number of boulders and some smaller stones on the surface but comparatively few stones in the soil. When the surface stones are removed, these areas may be cultivated satisfactorily.

The greater part of the Guelph stony loam is found in two large areas: one covering the greater part of Grey county, and the other parts of Peel, Halton, Wellington, and Wentworth counties. Small areas are found in southern Bruce, northern Huron, and southwestern Victoria counties. All of these areas are strongly morainal and the greater part of the surface is rough and hilly.

Although the Guelph stony loam produces good crops, the large amount of stones and the rough topography make cultivation difficult. Where the amount of stones is not too great and the slopes moderate, good crops of grain and forage crops are produced. The greater part of the type, however, is best adapted to pasture.

Guelph Sandy Loam.—The Guelph sandy loam consists of a brown to light brown sandy loam underlain at about eight inches by a yellowish brown to reddish brown, sandy loam or sand. The sand is usually of the finer grades, fine and very fine sand predominating. Some pebbles are found in both surface and subsoil, but the amount is usually greater in the subsoil.

LAKE
HURON
Owen Sound
Nottawasaga Bay
Collingw
Goderich
Guelph
Kitchener
St Marys
Woodstock
Brantford
London
Sarnia
Petrolia
Simcoe
St Thomas
Lake St Clair
Chatham
Windsor
LAKE
ER


Lake Simcoe
Lake Scugog
Peterborough
Rice Lake
Belleville
Kingston
Trenton
Toronto
LAKE ONTARIO
North Ast.
Map of
RECONNAISANCE SOIL SURVEY
of
SOUTH WESTERN ONTARIO
showing approximate boundaries of soil series
By Department of Chemistry, Ontario Agricultural College
1923
Scale of Miles
10 5 0 10 20 30 40
Legend
Dunkirk
Lockport
Haldimand
Hastings
Clyde
Guelph
Milton
London

West of Lake Simcoe and south of Barrie there is a large area with a sandy loam surface underlain, at twelve to fifteen or twenty inches, by a clay loam. This clay loam subsoil is similar to that found in the London clay loam. The Guelph sandy loam was formed of the unaltered glacial limestone material. There are indications, however, that in some places at least the material from which this soil was derived contains a larger percentage of non-calcareous material than is the case with the other limestone soils.

In some sections, particularly in southern Simcoe and northern Peel counties, the calcareous material is not limestone fragments, but marl.

The largest area is found in Northumberland, Hastings, Peterborough, Victoria, and Durham counties, and the other large areas around Hespeler and Preston in Waterloo county, and between Paris and Woodstock farther west. Smaller areas are found in Huron, Bruce, Grey, and Wellington counties.

The light texture and thorough drainage make the Guelph sandy loam a good soil for fruit and vegetables in the southern sections. Potatoes do well, and more of this crop should be grown. The steeper slopes erode badly and they should be kept in pasture.

Guelph Loam.—The Guelph loam consists of a brown to lightly reddish brown loam, changing to an average depth of ten inches to a reddish brown or yellowish brown loam. There are usually a few pebbles and small stones in the surface soil, but considerably more in the subsoil. The amount of pebbles usually increases with depth. In many places, pebbles are so thick within sixteen to twenty inches of the surface that it is impossible to bore deeper with a soil auger. This soil was formed by the weathering of glacial limestone drift under good drainage conditions.

This is the most extensive type of the Guelph series. It extends in a broad belt from Wingham and Walkerton on the west, to Creemore and Shelburne on the east, then turns south and extends in that direction past Guelph and Galt to the border of the old lake bed south and east of Paris. Other large areas are found between Lake Simcoe and Lake Scugog, between Lake Scugog and Lake Ontario and along the Trent River south of Campbellford. Smaller areas are found in Brant, Oxford, Middlesex, Perth, Wellington, Victoria, Peterborough, Durham, Northumberland and Hastings counties. Most of the smaller areas are found on small moraines and eskers, but the large area occupies intermorainal areas as well as the moraines.

The rough areas, which are found on the Wyoming, Waterloo, Paris, and Oak Ridges moraines, are rather extensive, yet they form only a small part of the type.

This is an excellent soil for all crops grown in this section. The light texture makes it easy to cultivate and the good natural drainage removes excess water quickly so crops may be planted early in the spring.

LONDON SERIES.

The London series includes soils with grayish brown to brownish gray surface soils. The dry surface soil in plowed fields appears quite gray, but the moist soil is always a grayish brown or brownish gray. Beneath the surface layer there is a subsurface layer of yellowish brown material which grades into a yellow brown and gray mottled heavy clay loam or clay subsoil. This impervious subsoil, which prevents adequate underdrainage and makes the soils wet and cold, is one of the distinguishing characteristics of the London soils. In all the London types, many limestone pebbles are found in both surface soil and subsoil,

the amount usually being greater in the subsoil. The amount, however, is not sufficient to materially affect the drainage.

The London series occupies the greater part of Middlesex, Perth, and Oxford counties. This series, like the Guelph series, was formed from glacial limestone material, but the differences in drainage in these two series have produced soils differing greatly in many respects. With the exception of a few rough, hilly morainal areas between Clinton and Wingham, where the soils have an impervious subsoil and so are classed with the London types, all of the London soils have gently undulating to rolling topography.

Four types were recognized in the London series: the loam, the silt loam, the clay loam, and the silty clay loam. The clay loam is the most extensive, having a greater area than all the other types combined.

London Loam.—The surface of this type is gently undulating to gently rolling. It is found associated with the Guelph loam and occupies depressions between ridges of that type. Many small areas are found in the section between Guelph and Fergus and east of Grand River. Only two of these areas were large enough to show on the map. The others are so small that they could not be shown separately, so they are included in the Guelph loam.

Although less desirable than the better-drained Guelph loam, this type is a good soil for general farming and stockraising.

London Silt Loam.—The surface is gently undulating to rolling. A large number of narrow morainal ridges are found. The higher part of these ridges is Guelph loam, while the lower slopes are occupied by London silt loam. With the exception of these ridges, London silt loam occupies the greater part of these areas, although there are a few small spots of London loam on the tops of some of the low ridges and some small areas of London clay loam in low places and on some of the higher ground where the surface has been washed away.

Typically, the London silt loam consists of a brownish gray to yellowish gray silt loam, changing at an average depth of eight inches to a light yellow to yellowish gray silt loam. At an average depth of fifteen inches, this subsurface layer is underlain by a gray, yellow, and brown mottled clay loam. Small limestone pebbles are found in the subsoil, and, in a few places, in the surface soil.

Two large areas of the London silt loam were mapped. The larger one, which lies between Stratford and Clinton, occupies a large part of McKillop, Logan, Ellice, Tuckersmith, Hibbert, and Fullarton townships, and a small part of Downie township. The other area occurs north of London and Missouri West townships.

Like the other types in this series, the London silt loam was developed by the weathering of glacial limestone drift, under moderately poor drainage conditions. Artificial drainage is needed to remove excess water during wet seasons. On account of the lighter texture, this type is easier to cultivate and is a little earlier than the London clay loam. Both are well adapted to the growth of grains and grasses and are good soils for general farming and stockraising.

London Clay Loam.—The London clay loam consists of a grayish brown heavy loam to clay loam underlain at about eight inches by a yellow brown and gray mottled clay loam which gradually becomes heavier with depth grading into a bluish gray and brown mottled clay at sixteen to twenty-four inches. Some limestone pebbles are invariably found in the subsoil and they are frequently found in the surface soil. The dry surface soil, as it appears in ploughed fields, is quite gray, but the moist soil is a grayish brown.

Small areas of Guelph loam are found on narrow moraines and eskers within the areas of London clay loam. Although these ridges are quite distinct they

are too small to show on the preliminary map. Several of these areas are found in Arthur, Maryborough, Elma, Downie, and Oxford townships. Small areas of the London silty clay loam, which are included in the London clay loam, are found in Peel township.

The London clay loam, which is the most extensive of the London types, occupies the greater part of Oxford, Middlesex and Perth counties, a large part of Wellington and Huron counties, and small areas in Bruce, Waterloo, Dufferin, and Brant counties.

This type was derived from glacial limestone drift. With the exception of a few areas on the terminal moraines in Huron and Bruce counties, all of the London clay loam occupies ground moraine or inter-morainal country and the surface is gently undulating to rolling. Most of the type has sufficient relief for good surface drainage, but the heavy subsoil prevents rapid removal of the water in wet seasons. Artificial drainage will improve this condition but open ditches may be necessary in some places as tile may not draw in the heavy subsoil.

This type is best adapted to general farming and stockraising. Cereals and forage crops do well.

London Silty Clay Loam.—The London silty clay loam is a grayish brown silty clay loam changing at six to eight inches to a bluish gray mottled with yellowish brown silty clay loam or silty clay, which changes at an average depth of twenty inches to a bluish gray and yellowish brown mottled silty clay containing some white or light gray spots of partially decomposed limestone. Many undecomposed limestone fragments are also found, usually beginning at about twenty inches below the surface.

The material from which this soil was formed appears to have been deposited in a temporary lake which was formed during the early stages of "Ontario Island." In texture this soil resembles the heavier phases of the Clyde clay loam found in depressions on the upland, but, on account of the light-coloured surface and the large amount of lime present, its characteristics are similar to those of the London series and so it is classified with the London types.

This type appears in a large area in Mornington, Wellesley and Maryborough townships. The type was also encountered on the east side of the Conestogo River in Peel township, but the areas are so small that they could not be shown on the map, so they were included in the London clay loam.

The surface of this type is gently undulating. There is sufficient relief for fair surface drainage, but the heavy character of the soil makes artificial drainage necessary to remove excess water quickly.

This is a good soil for general farming and stockraising. Cereals and forage crops produce well.

GLACIAL SHALE AND SANDSTONE SOILS.

With the exception of a small area near Hamilton, where the ice deposited shale and sandstone material upon the limestone rock, all of these soils are underlain by shales and sandstones. These underlying rocks have furnished a large part of the soil material and the weathering of this material has produced soils which differ markedly from the glacial limestone soils.

The glacial shale and sandstone soils occupy a large area on the north side of Lake Ontario. This area lies south of the Oak Ridges moraine and extends from Hamilton to the York-Ontario county line. In this region the movement of the ice was from the Ontario basin inland, and the soil material was derived from the underlying rocks. Farther north the direction of ice-flow was south

to southwest, and, as already mentioned, a large part of the soil material is limestone from the Trenton limestone to the north and east; and marl, which probably came from deposits in shallow lakes and marshes similar to those found in central Simcoe county at the present time. In central and northwestern Simcoe county, a large area is underlain by shales and sandstone, but the glacial deposits were modified by glacial lake waters. On the north side of Niagara peninsula the greater part of the shale and sandstone material has been covered by lacustrine deposits, but a few small areas have been modified to only a slight extent, so they are included in the glacial shale and sandstone soils. Several large areas of these soils are found in Grey county just below the Niagara escarpment.

Two series, the Milton series and Lockport series, are included in the glacial shale and sandstone soils.

MILTON SERIES.

The soils of the Milton series were formed by the weathering of glacial shale and sandstone drift. There is a slight admixture of granitic material, and, in some places, a few limestone pebbles, but the greater part of the soil material came from the underlying shales and sandstones, and a large number of small fragments of these rocks are found in both surface soil and subsoil.

This series includes soils with light brown to brownish gray surface soils, and brown or drab, mottled with bluish gray, subsoils. The colours are similar to those found in the London soils, but, as a general rule, in the Milton series, the colours are not so bright as in the London soils. These soils generally have fairly good surface drainage but poor underdrainage.

The Milton soils occupy a large area in the central and southern parts of Halton, Peel, and York counties. Smaller areas are found in Grey, Simcoe, Wentworth and Ontario counties.

Three types are included in this series, the Milton loam, the Milton clay loam, and the Milton clay.

Milton Loam.—The Milton loam consists of a light brown heavy loam underlain, at an average depth of eight inches, by a yellowish brown or drab, mottled with bluish gray heavy loam. This subsoil layer becomes heavier with depth grading into a clay loam or clay at ten or twelve inches below the surface.

The Milton loam occupies a large area of undulating to gently rolling land in southern York county. Smaller areas are found in Wentworth, Halton, Peel, Dufferin, Simcoe, and Grey counties.

This type produces good yields of grain and hay and is a good soil for general farming.

Milton Clay Loam.—The Milton clay loam consists of a light brown to brownish gray clay loam underlain, at an average depth of eight inches, by a light brown or drab, mottled with bluish gray heavy clay loam to clay. The texture becomes heavier with depth and the bluish gray colour becomes more prominent. In some places ochreous yellow iron stains are found and occasionally some white or gray lime concretions. These lime concretions are usually found at thirty to forty inches below the surface.

The Milton clay loam occupies a broad belt extending across the southern and central parts of Halton and Peel counties and across the south central part of York county. Smaller areas are found in the northern part of Grey county and in central and southern Simcoe county.

Although the heavy subsoil is almost impervious to water, making the soil wet and cold in the spring, good yields of grain and hay are produced. This is a strong soil and it is adapted to general farming and stockraising.

Milton Clay.—The surface soil of the Milton clay, to an average depth of eight inches, is a grayish brown to brownish gray heavy, silty clay loam or clay. The subsoil is a bluish gray, brown, and drab mottled heavy, silty clay or clay. The surface is flat and poorly drained. Only two small areas of Milton clay were mapped and these include small areas of the Milton clay loam These two areas are found along the Peel-York county line.

This soil is best adapted to the growth of grass.

LOCKPORT SERIES.

The Lockport series includes soils with reddish gray to reddish brown surface soils and Indian red subsoils. As a general rule, the soil material is thin and has been derived from the underlying shales, which are frequently within three or four feet from the surface. There is a slight admixture of the other material brought in by the ice or the glacial lake waters; but the amount is so small it has had only a slight influence on the character of the soil. In Ontario, the greater part of the area lies above the highest level of lake waters, so this series has been placed in the glacial shale and sandstone group.

Only one type, the Lockport clay, was mapped in southwestern and central Ontario.

Lockport Clay.—The Lockport clay consists of a reddish gray to reddish brown, heavy, silty clay loam to silty clay, underlain at six to eight inches by an Indian red, heavy, compact, unctuous, silty clay. Bedrock is usually near the surface, in some places within the three-foot section.

The principal areas of this type are found between Owen Sound and Collingwood. All of these areas are at a considerable elevation above Georgian Bay, and most of them are rough and hilly. A long, narrow strip extends from a few miles north of Owen Sound to a few miles west of Cape Commodore. Smaller areas are found along the north side of Niagara peninsula between the escarpment and Lake Ontario and north and east of Hamilton. The surface of these areas is undulating to rolling.

The Lockport clay is a rather poor soil, especially north of Owen Sound and between Owen Sound and Collingwood where the soil is very shallow. The heavy clay subsoil retains moisture for a long time, making the soi' wet and cold in the spring. When it does dry out, t bakes and forms clods which are difficult to handle. There are some good vineyards on this type, but, as a general rule, it is not a good soil for grapes or any other kind of fruit. It is best adapted to grass, but, in the more hilly sections, the slopes are badly eroded and grass does not grow well on the heavy clay subsoil.

GLACIAL LAKE SOILS.

When the ice retreated, large lakes were formed, which covered a large part of southwestern and a smaller area in central Ontario. Large rivers were developed, and these streams gathered up large quantities of rock material from the dirty ice and carried it into these glacial lakes. Most of the coarse material, such as gravel and sand, was deposited as deltas near the mouths of the streams, while the finer material was carried farther away and deposited in quiet waters. Some coarse material was deposited as long, low ridges along the lake shores. Several of these beach ridges mark former shore lines. Some of the terminal moraines were deposited in the lake and were reworked to some extent by the water. Some sand dunes have been formed by the action of the wind on the

coarser material in deltas, moraines, and beach deposits. These, however, are not important except in some areas along the present lake shores. All of the soils derived from glacial material which has been reworked by water and deposited in the lakes, has been grouped in the glacial lake province.

The glacial lake soils include not only soils lying within the old lake bed but also some areas on the upland which were formerly ponds or marshes. Other areas, where the action of the wind has produced sand dunes, having characteristics similar to those in the lake bed, are also included with the glacial lake soils. A few smaller areas, within the old lake bed, are grouped with the glacial drift soils, because the soil material is glacial drift which has not been modified by lacustrine sediments. The most of these areas are in Huron and Bruce counties, where the surface is rolling. Only a few glacial streams emptied into the lake in this section, and the ice remained for a much longer time than farther south. On this account the waters remained for a comparatively short time, and areas at some distance from the glacial streams received only a thin deposit of sediments. The rolling topography has favoured erosion, which has since removed the lacustrine material from some areas, and exposed the drift material from which the soils have been formed.

The glacial lake soils are found in southwestern and central Ontario and include eleven types. These are grouped in five series: the Dunkirk, the Haldimand, the Clyde, the Warners, and the Hastings series.

DUNKIRK SERIES.

The Dunkirk series includes brown to light brown or yellowish gray soils with reddish brown, yellowish brown, or yellow subsoils. Although this series is classed as Glacial Lake series, there are some areas of dune sand on the upland which resemble the dune sand within the old lake bed so much that they are also included in the Dunkirk series. The lacustrine material, which has given rise to Dunkirk soils, was deposited along the present, or along previous, lake shores, in waterlaid moraines, and as deltas where the glacial streams emptied into the lakes. Some of this material, particularly in some sections along the present lake shores, has been reworked by wind.

These soils are found along the shores of Lakes Huron, Erie and Ontario, in places where large quantities of beach sand have been deposited, along former beaches in the old lake bed, along waterlaid moraines, and in delta deposits where glacial streams emptied into the lake. Large areas are found in Bruce, Huron, Middlesex, Lambton, Essex, Kent, Elgin, Norfolk, Brant, Wentworth, Lincoln, Welland, Simcoe, York, Ontario, Durham, and Northumberland counties. Most of the upland dune sand is found in east Dufferin, south Simcoe, north Peel, north central York, central Ontario, central Durham, and central Northumberland counties.

As the Dunkirk series includes only well-drained soils with thoroughly oxidized subsoils, only the lighter-textured types are found. Sand or gravel is usually found within three or four feet of the surface. Three Dunkirk types are mapped: the Dunkirk fine sand, the Dunkirk sandy loam, and the Dunkirk loam.

Dunkirk Fine Sand.—The Dunkirk fine sand consists of a yellowish gray to light brown fine sand, changing, at four to eight inches, to a yellowish brown or reddish brown fine sand. Except near areas of other types, the subsoil is generally uniform in colour and texture to a depth of three feet or more. This soil is easily blown about by the wind where it is not covered with vegetation.

The greater part of this type was derived from glacial drift reworked by water. These areas were deposited as deltas, water-laid moraines, and beach ridges. Large areas of this type are found in Simcoe, Dufferin, York, Ontario, Durham, Northumberland, Peel, Welland, Brant, Norfolk, Elgin, Kent, Essex, Lambton, Middlesex, and Bruce counties.

The thorough drainage, and open, porous condition of the soil makes this type an excellent soil for vegetables, small fruits, beans and potatoes, wherever the topography is not too rough and there is sufficient organic matter present to bind the soil together. Apples and peaches also do well. There are, however, large areas where there is very little organic matter in the soil and it blows readily. In these sections, more organic matter will have to be incorporated in the soil. Sand-binding grasses should be planted and the surface kept covered with vegetation as much as possible. The rough topography along the sand dunes makes these areas hard to manage.

Dunkirk Sandy Loam.—The Dunkirk sandy loam consists of a brown sandy loam which changes, at six to ten inches, to a light brown or yellowish brown sandy loam. In many places the subsoil contains considerable gravel and small stones. This gravelly layer may appear within twenty inches of the surface, but frequently no stone or gravel is found within the three-foot section.

The dry surface soil, as it appears in ploughed fields, varies from yellowish gray to light brown, but the moist soil is always brown.

The principal areas of the Dunkirk sandy loam are found between Hamilton and Brantford, south of Brantford and Paris, southwest of London, south and west of Collingwood, in the Beaver and Bighead valleys in Bruce and Huron counties, in northeastern and south central Simcoe, northern Ontario, south Durham and south Northumberland counties.

This soil is best adapted to truck and fruit-growing. Apples, peaches, grapes, vegetables and potatoes are grown and all produce well on this soil.

Dunkirk Loam.—The surface soil of the Dunkirk loam is a light brown to brown friable loam, varying in depth from six to ten inches. The dry soil, as it appears in ploughed fields, is yellowish gray, but the moist soil is always a light brown or brown. The texture varies from a heavy loam or silty loam to a light loam. In Bruce county, considerable stone is found in this type.

The principal areas of the Dunkirk loam are found south and east of Collingwood, in the Beaver and Bighead valleys, southwest of Owen Sound, near London, around Brantford, south and west of Hamilton, along the north side of Niagara peninsula, partly above and partly below the escarpment, around Lake Simcoe and along the north shore of Lake Ontario, west of Port Hope.

Although this is a good soil for general farming, it is best adapted to truck and fruit-growing. Good crops of vegetables, potatoes, apples, peaches and grapes are produced.

HALDIMAND SERIES.

The Haldimand series includes soils which have grayish brown to brownish gray surface soil, and gray to bluish gray, mottled with brown, subsoils. These soils were formed from glacial lake sediments deposited in quiet water. Although the surface has sufficient relief for fair surface drainage, thus preventing an accumulation of organic matter, the subsoil is so heavy that water does not move through it readily. On this account these soils are wet and cold in the spring.

These soils occupy the greater part of the Niagara peninsula, and a large part of the old lake bed in Bruce and Huron counties. Large areas of Haldimand soils are also found in Lambton, Middlesex, Elgin, Kent and Essex counties.

Two types in this series were recognized, the Haldimand clay loam, and the Haldimand clay.

Haldimand Clay Loam.—The Haldimand clay loam consists of a grayish brown to brownish gray clay loam, underlain, at six to nine inches, by a gray to bluish gray, mottled with yellowish brown, clay loam, which becomes heavier with depth, and changes, at fifteen to twenty-two inches, into a bluish gray and yellowish brown mottled clay. On account of this heavy clay subsoil, water drains away very slowly, making the soil cold and wet even where the slopes are moderately steep. With the exception of a few places where stream erosion has formed steep slopes, all of this type has a gently undulating to rolling surface.

The Haldimand clay loam occupies large areas in Bruce, Huron, Middlesex, Lambton, Essex, Kent, Elgin, Brant, Wentworth, Lincoln, and Welland counties.

On account of the impervious subsoil, this is a wet, cold soil and artificial drainage is advisable to remove the excess water. This type is best adapted to the growth of cereals and forage.

Haldimand Clay.—The Haldimand clay consists of a grayish brown, heavy clay loam to clay underlain, at six to eight inches, by a bluish gray mottled with yellow and brown unctuous clay. In general, the texture gradually becomes heavier with depth and the yellow mottlings are replaced by brown. In some sections there are white limestone spots at thirty to forty inches below the surface. Very little sand is found in either surface soil or subsoil.

As a general rule there is a great depth of lacustrine sediments in all the areas of Haldimand clay, but in a few places, such as that near Hagersville, there are only a few inches of soil material upon the solid limestone rock. These areas are a gradation toward Hastings stony clay loam.

This type was formed from glacial lake deposits, and, like the Clyde clay, includes only the fine sediments. The surface, however, is not flat like the Clyde clay, but gently undulating to rolling, except in eroded areas near the streams where the slopes are steep and broken. Although the soil material is largely limestone, some shale and sandstone material is included. The presence of the latter is especially noted in Bruce county along the Saugeen river, where material from the Cataract formation has given a distinctly reddish tinge to the subsoil. There are also a few places in Welland county where Medina shale material has given a reddish tinge to the soil.

This type occupies almost all of Haldimand county and the greater part of Welland county. Large areas are also found in Lincoln, Wentworth, Elgin, Essex, Lambton, Middlesex, Huron, and Bruce counties.

The heavy texture makes this soil difficult to work. It retains water for a long time after it becomes wet, and, when it does dry out, soon becomes so hard that the plough turns up great clods. Artificial drainage is advisable and more organic matter should be incorporated in the soil to improve its physical condition. This type is best adapted to the growth of forage crops. In some places alfalfa does well.

CLYDE SERIES.

The Clyde series includes soils with dark gray to black surface soils, and yellowish gray, and blue to bluish gray and drab mottled subsoils. As a general rule, the lighter-textured members of the series have the yellowish gray and gray subsoils, and the heavier-textured ones the bluish gray and drab.

Like the Dunkirk and Haldimand types, these soils were derived from reworked glacial drift material deposited as sediments in glacial lakes. The different conditions under which they were formed, however, has produced soils

with markedly different characteristics. In the Dunkirk, the undulating surface and the porous subsoil have produced soils with the rich brown colours which show good drainage and thorough oxidation. The undulating to rolling surface and the heavier subsoil of the Haldimand series have produced the gray and dead-brown colours found in poorly-drained soils which are low in organic matter. The Clyde soils, however, were developed in flat areas where water stood for a large part of the year. This has favoured the accumulation of a large amount of organic matter which gives the dark colour to the surface soils of the Clyde series. On the upland, many depressions, which were formerly lakes or ponds, have been partially filled by an accumulation of organic matter mixed with more or less inorganic material washed in from the surrounding slopes. In some of these areas the amount of organic matter is very high, forming muck or peat, but, in others, there is only sufficient organic matter to produce eight to twelve inches of dark gray to black material on the surface. In the latter areas the soil does not differ greatly from the Clyde soils in the old lake bed, so they are included with those in the Clyde series.

Nearly all of Essex county and a large part of Kent and Lambton counties are included in this series. Large areas are found in northern York, western Simcoe, western Bruce, southwestern Huron, and central Perth counties, and in the Niagara peninsula.

Clyde Sandy Loam.—The Clyde sandy loam consists of a dark brown to black sandy loam, which changes, at six to twelve inches, to a yellowish gray sandy loam. This subsurface layer is underlain at about fifteen to twenty inches by a yellow brown and gray mottled subsoil, which varies in texture from a clay loam to a sand. In some places the subsoil is a gray sand.

The dry surface soil is brown, but when moist it is a dark brown to black. The darker areas are found where a thin layer of muck has been mixed with the underlying sandy loam material, thus forming a black sandy loam.

The texture varies, in the surface soil, from a fine sandy loam to a sandy loam, in the subsurface soil, from a sandy loam to a clay loam. Part of the area south of Windsor has considerable gravel in the subsoil.

This soil is derived from glacial drift material which has been reworked by water. It occupies small depressions and larger flat areas where poor drainage has favoured the accumulation of organic matter. Small ridges of Dunkirk sand and Dunkirk sandy loam are often included in this type, as they are too small to show separately. Near Lake St. Clair there is an area mapped as Clyde sandy loam. A large part of it is uncultivated, and has from four to six inches of muck on the sandy loam material. The cultivated part is a brown to black sandy loam and cultivation will soon bring the other part into the same condition, so the entire area is mapped as the Clyde sandy loam.

This type occurs in Essex, Kent, Lambton, Huron, Bruce, Middlesex, Elgin, Norfolk, Simcoe, York, Haldimand, Welland, and Lincoln counties.

When drained, this is an excellent truck soil. It is especially well adapted to the growth of onions and celery. An area at Hepworth, near Wiarton, is devoted to the growing of potatoes.

Clyde Loam.—The Clyde loam is a dark brown loam underlain, at six to twelve inches, by a bluish gray and yellowish brown mottled loam which changes, at sixteen to twenty-four inches, to a bluish gray and yellowish brown mottled heavy loam to clay loam containing some sand pockets and, in some places, a few pebbles.

The principal areas of Clyde loam are found in western Simcoe county and

in the Niagara peninsula. Small areas are found in other sections of the old lake bed.

This type is adapted to general farm crops and, when well drained, is a good truck soil.

Clyde Clay Loam.—The Clyde clay loam consists of a dark gray to almost black clay loam underlain, at six to twelve inches, by a bluish gray mottled with yellowish brown clay loam which becomes heavier with depth, grading into a clay at fifteen to twenty-four inches below the surface. In many of the larger areas there is a narrow border of this Clyde clay loam surrounding an area of muck. In some, however, the muck has been burned off, leaving a dark gray to black clay loam which is almost heavy enough, in some places, for a clay. All the larger areas of Clyde clay loam include some small areas of muck. In all cases, the chief characteristics are the poor drainage and the high percentage of organic matter.

Large areas of this type are found in Perth county. Smaller areas are found in various places in the old lake bed and in areas of the London clay loam. Small depressions in the London clay loam invariably have Clyde clay loam, while similar depressions in areas of the Guelph loam are occupied by muck. Seepage from the well-drained Guelph loam has kept the low places wet, thus forming a sufficiently large accumulation of organic matter to form a muck.

All of the areas of Clyde clay loam are in need of drainage. Many cannot be cultivated until drained. This is a rich soil and when well drained produces good crops of grain and hay.

Clyde Clay.—The Clyde clay consists of a dark gray to almost black heavy, silty clay loam to silty clay underlain, at six to ten inches, by a bluish gray to drab heavy clay or silty clay which is sometimes mottled with red and yellowish brown spots. The amount of mottling may become greater or less with depth but the change is gradual.

Nearly all of Essex and a large part of Kent and Lambton counties are included in the Clyde clay. Other areas of this type are found in Huron, Elgin, Middlesex, Haldimand, Welland, and Lincoln counties.

This is a rich soil, but the flat surface and heavy soil makes artificial drainage necessary if maximum yields are to be produced. Some areas are so very wet that they cannot be cultivated until they are first drained. A large area south of Lake St. Clair is only slightly higher than the lake and the water can be removed only by pumping from the drainage canals into the lake. When drained, the Clyde clay produces good yields of corn and hay.

WARNERS SERIES.

The Warners series includes soils with dark brown to black surface soils and gray, marly subsoils. These soils occupy flat, marshy areas where there has been a large accumulation of marl, in part by the deposition of calcium salts by plants and in part by the accumulation of shells of snails and other land animals. There is also a large accumulation of organic matter which gives the dark colour to the surface.

Only one type, the Warners loam, has been mapped in southwestern and central Ontario.

Warners Loam.—The Warners loam is a dark brown to black loam underlain, at an average depth of eight to twelve inches, by a layer of white or gray marl.

The typical subsoil is almost a pure marl, but, near areas of other types,

considerable sand, silt, and clay has been mixed with the marl. The depth of marl is more than forty inches in most places, but is frequently only a few inches deep near areas of other types. In a few places, several inches of marl were found immediately below the surface soil, then a layer of clay loam, and then another layer of marl.

This soil was derived from marl deposits mixed with a small amount of lacustrine sediment and a large accumulation of organic matter.

The only areas of this type found in southwestern and central Ontario are in Simcoe county near the Nottawasaga river. One of the areas surrounds a small lake known as Marl Lake. The shores of this lake are covered with marl, and it is quite evident that the surrounding area was once a part of the lake. The lake has been gradually filled by the deposits of marl and the sediments washed in from the surrounding higher ground. Plants have grown in the shallow water along the border of the lake, advancing farther and farther from the shore as the water has gradually become shallower. The partly decomposed remains of these plants give the dark colour to the surface soil. The history of the other areas has probably been similar except that the process has gone farther and the lakes have become entirely obliterated.

HASTINGS SERIES.

The Hastings stony clay loam includes gray to brown soils which were derived from a thin layer of lacustrine sediments deposited on limestone rock. The soil material varies from six to fifteen inches deep, and the underlying rock is partially decomposed in many places, and many rock fragments are found in both soil and subsoil. It seems quite certain that the soil material is partly residual material from the underlying rock and partly lacustrine sediments.

We have mapped large areas of this soil series in Lennox and Addington, Hastings, Prince Edward, and Bruce counties. Apparently these soils were formed where the ice removed almost all of the unconsolidated material, and the lake waters, which afterwards covered them, deposited only a slight amount of lacustrine material. Only one type, the Hastings stony clay loam, was mapped on the preliminary survey. There are, however, areas which are fairly light in texture, and it is probable that a more detailed investigation will show some small areas of Hastings loam.

Hastings Stony Clay Loam.—The Hastings stony clay loam consists of a gray to brown clay loam underlain, at an average depth of eight inches, by a brown to drab heavy clay loam. Both soil and subsoil contain a large amount of limestone fragments, and solid limestone rock appears within ten inches to fifteen inches of the surface. In many places, however, the underlying rock is partly decomposed. This condition was noted in a large part of Prince Edward county and in some parts of Hastings and Lennox and Addington counties.

There is a considerable variation in the amount of stones in both surface and subsoil. As a general rule, the larger amount of stone is found where the soil has a brown colour and considerable decomposition has taken place in the underlying rock. The smaller amount of stone and the gray soil is found where there has been little decomposition in the underlying rock.

This soil was derived, in part, from residual limestone material, and, in part, from lacustrine sediments. During the glacial period, the ice apparently removed all decomposed rock in some places and only part in others. On the withdrawal of the ice, glacial lake waters covered this area, and a small amount of lacustrine material was deposited. Where these lacustrine sediments are

deep, either Dunkirk or Haldimand soils have developed; the former on well-drained, the latter on poorly-drained areas. But where the lacustrine deposits were shallow, the Hastings soils have developed. The grayer areas are derived mainly from lacustrine material and are a gradation towards the Haldimand soils, while the brown areas contain much more residual material.

This soil occupies large areas of gently undulating to rolling land in Prince Edward, Hastings, Lennox and Addington counties. Where the undecomposed rock is near the surface, this soil is only fit for pasture, but where the underlying rock is partly decomposed, good crops of grain and fruit are grown.

MUCK AND PEAT.

When the ice disappeared from southwestern Ontario, it left a level surface which had many depressions with no natural drainage outlets. These depressions filled with water, forming lakes and ponds, some of which are still in existence. Others have gradually filled by the accumulation of organic matter mixed with more or less inorganic matter washed in from the surrounding slopes. In some of these depressions, the amount of organic matter is only sufficient to give a dark brown colour to the surface soil. These areas are included in the Clyde series. Other areas have a large amount of organic matter, frequently three or more feet in depth, in all stages of decomposition. These areas are classed as muck and peat.

The term peat is frequently applied to all of this material, but there is a difference in agricultural value between the brown fibrous material and the black, thoroughly decomposed portion, and it seems best, as Coffey suggests (Reconnaissance Soil Survey of Ohio), to confine the term peat to the former and to call the latter muck. There is, however, no sharp line of division between the two, all gradations being found from undecomposed plant remains to thoroughly decomposed organic matter. In many places organic matter in all stages of decomposition are found intimately mixed together.

Muck and peat are formed under very wet conditions, which have prevented the rapid decomposition of organic matter. They are found to some extent in the old lake bed, but their chief development is in depressions on the upland, particularly in morainal sections. Depressions surrounded by well-drained soils like the Guelph types invariably contain muck and peat, as seepage keeps these areas constantly wet. In depressions surrounded by soils with poor underdrainage, like the London clay loam, there is often only a slight accumulation of organic matter around the border and the muck and peat is surrounded by a narrow border of Clyde clay loam.

The depth of the muck and peat in the different areas varies from a few inches to as much as twenty feet. In East and West Luther townships part of the area is twenty feet or more in depth and is covered with certain types of grasses and sedges but does not produce large tree growth. A similar condition is found in the large area in Ellice township. In Greenock township, however, there is a large area that is comparatively shallow and it is covered with trees. Some areas classed as Clyde clay loam were formerly covered with muck and peat, but this material has been burned off, leaving a dark gray to black soil. Where the depth of organic matter is less than eight inches, it is classed with the Clyde soils, as cultivation mixes the organic matter with the underlying material and soils of that series are formed.

Large areas of muck and peat are found south of Welland, south of Brampton, north of Stratford, west of Walkerton, northeast of Dundalk and Arthur, and

south of Lake Simcoe. Many small areas are found in the last section as well as in all parts of the country.

All areas of muck and peat require drainage before they can be cultivated. Quite frequently a layer of varying thickness of greyish marl is found in muck areas. It may occur a few inches below the surface or down in the subsoil at three feet or more. If it is practical to remove some of this marl and apply it to the top-soil, the texture and fertility will be improved. (Marl is high in calcium carbonate.)

Muck soils respond to treatment with phosphatic and potassic fertilizers. They are often quite acid and require liming. There is usually an abundance of nitrogen.

When well drained they are excellent soils for celery, onions, sugar beets and all kinds of truck crops.

WORK ON DEMONSTRATION PLOTS.

A soil survey includes: First, mapping and classification of the soils; second, a determination of the amount of plant food, in the soil by physical and chemical analyses; and, third, the laying down of cultural and fertilizer experiments.

The mapping and classification of the soils has been treated in a previous part of this bulletin. Nearly two hundred samples of soils representing all of the series and types found in the Province have been analyzed, but as even this is not sufficient to give an average composition that would be really representative they are not included in this report.

We have, however, made use of the Survey in establishing three demonstration plots, and we have laid down a large number of co-operative experiments, all of which have been placed on definite types of soils. This is important because the results obtained from these experiments will be applicable to the same type wherever it may be found.

The demonstration plots are at Guelph, Simcoe and Welland, and it may not be out of place in this bulletin to outline the plan of the experiments undertaken on these plots.

THE GUELPH PLOT.

The Guelph Plot is on a Guelph Loam (see description under Guelph Series), and consists of three acres, part of the College Farm. The plot was started in 1915, and was planned with the double purpose of studying the soil type and securing data for classroom work. A three year rotation is followed: Mangels, Barley and Hay. A fourth range is devoted to fertilizer experiments on permanent pasture to ascertain the influence of the different fertilizer constituents on the growth of grasses.

The plan of the experiment is as follows:—

Plot No.	Fertilizer Applied	Lbs. per acre
101	No Fertilizer	...
102	Sulphate of Ammonia	200
	Superphosphate	400
	Muriate of Potash	200
103	Superphosphate	400
	Muriate of Potash	200
104	Sulphate of Ammonia	200
	Muriate of Potash	200
105	Sulphate of Ammonia	200
	Superphosphate	400
106	No Fertilizer	..
107	Nitrate of Soda (2 dressings).	250
	Superphosphate	400
	Muriate of Potash	200
108	Nitrate of Soda	250
	Superphosphate	400
	Muriate of Potash	200
	(Radio-active fertilizer—5 lbs. per plot.	
109	Blood Meal	300
	Superphosphate	400
	Muriate of Potash	200
110	Calcium Cyanamide	250
	Superphosphate	400
	Muriate of Potash	200
111	Calcium Nitrate (2 dressings).	250
	Superphosphate	400
	Muriate of Potash	200
112	No fertilizer	...
113	Nitrate of Soda (2 dressings).	125
	Sulphate of Ammonia	100
	Superphosphate	400
	Muriate of Potash	200
114	Nitrate of Soda (2 dressings).	125
	Calcium Cyanamide	125
	Superphosphate	400
	Muriate of Potash	200
115	Nitrate of Soda (2 dressings).	85
	Sulphate of Ammonia	70
	Blood Meal	100
	Superphosphate	400
	Muriate of Potash	200
116	Nitrate of Soda (3 dressings).	500
117	Sulphate of Ammonia	400
118	No fertilizer	...
119	Sulphate of Ammonia	200
	Basic Slag	400
	Muriate of Potash	200
120	Sulphate of Ammonia	200
	Bones	325
	Muriate of Potash	200
121	Sulphate of Ammonia	200
	Rock Phosphate	1,200
	Muriate of Potash	200
122	No fertilizer	...
123	Sulphate of Ammonia	200
	Superphosphate	400
	Potassium Sulphate	200
124	Sulphate of Ammonia	200
	Superphosphate	400
	Drury's Feldspar	1,400
125	Drury's Feldspar	2,000
126	Sulphate of Ammonia	200
	Superphosphate	400
	Kelp to be applied later	1,000
127	No fertilizer	...
128	Sulphate of Ammonia	200
	Superphosphate	400
	Muriate of Potash	200
	Radio-active fertilizer	500
129	Sulphate of Ammonia	200
	Superphosphate	400
	Common Salt	400
130	Sulphate of Ammonia	200
	Superphosphate	400
	Muriate of Potash	200
	Common Salt	400
131	No fertilizer	...
132	Sulphate of Ammonia	400
	Superphosphate	800
	Muriate of Potash	400

Some interesting results have been obtained, one of which is the superiority of Nitrate of Soda as a source of Nitrogen for mangels.

THE SIMCOE PLOT.

This plot consists of six acres near the town of Simcoe. The soil is a Dunkirk sand in very poor condition. (See description of this type under Dunkirk Series.) The plot was taken over in the Fall of 1919. After discussing the matter with the farmers in the neighbourhood the following rotation was decided on:—1. Peas, 2. Hay, 3. Hoe Crop, 4. Wheat. Since canning peas are an important crop in this locality and on this soil it was thought desirable to sow to clover after the peas were taken off. By this method a cash crop was secured and, at the same time, a catch of clover for hay for the next season. The field was divided into five ranges with ten 1/10 acre plots in each. The fifth range was devoted to Market Garden Crops.

The fertilizer scheme for all ranges is as follows:—

Plot No.	Fertilizer Treatment	Rate per acre	Constituents.
		Tons	
1.	No Treatment	.....	Check
2.	Manure	10	Manure only
3.	Manure and Lime	Lime at 2 tons	M+Lime
		Lbs.	
4.	Manure+Lime+Acid Phosphate 16 per cent.	Acid Phos.=350	Phosphorus
5.a.	M+L+10 p. cent. Rock phosphate+sulphur	Rock Phos.=1,000 Sulphur=500	Phosphorus +Sulphur
b.	M+L+10 per cent. Rock Phosphate	.....	Phosphorus
6.	M+L+Basic Slag 10 per cent	560	Phosphorus
7.	M+L+		
	Sulphate Ammonia	200	Nitrogen+
	Acid Phosphate	350	Phosphorus
	Muriate of Potash	150	+Potash
8.	M+L+		
	Acid Phosphate	350	Phosphorus
	Muriate Potash	150	+Potash
9.	M+L+		
	Sulphate Ammonia	200	Nitrogen+
	Muriate Potash	150	Potash
10.	M+L+		
	Sulphate Ammonia	200	Nitrogen+
	Acid Phosphate	350	Phosphorus

It will be seen on perusal of this table that provision is made to try out the three common forms of phosphorus, and also to check a complete fertilizer against its various constituents.

Some very interesting data has been obtained with peas and potatoes, but it is too soon to make positive statements regarding the results.

THE WELLAND PLOT.

The object of this Demonstration Plot was to observe the effect of various forms of lime and chemical fertilizers together with a system of underdrainage on the Haldimand Clay. The plot consists of twenty acres situated on the Niagara Falls Road about a mile and a half from Welland, Ontario. The soil is a heavy Haldimand Clay, typical of the Crowland District. Operations were commenced on September 1st, 1920.

After consultation with representative farmers, keeping in mind the fact that this is a thickly populated district in which dairying is important, the following rotation was decided on: 1. Wheat, 2. Hay, 3. Oats, 4. Corn, 5. ½ Hay, ½ Fallow. The fifth range was divided, because, while a number of men on large farms could afford to fallow, others, on smaller places, had to use such acreage for hay. This gives an opportunity to compare sod plowed down and Summer Fallow as a preparation for wheat.

In the Spring of 1921, a complete underdrainage scheme, laid out by the Drainage Department at the College, was installed on 15 acres. A five-acre portion at the north end of the field was left undrained to act as a check. The ranges were planned to cross both the drained and undrained portions and each range was divided into 14 plots of 1/5 acre in size.

The Fertilizer Scheme for Ranges 1, 3, 4, 5, and 6 is as follows:

Plot	1.	Acid Phosphate	400 lbs. per acre.
"	2.	Rock Phosphate	1,000 lbs. 500 lbs. S. per acre
"	3.	Lime	2 tons Limestone Screenings
"	4.	Acid Phosphate	400 lbs. per acre, (80 lbs.)
"	5.	Rock Phosphate	1,000 " " (200 ")
"	6.	Basic Slag	600 " " (120 ")
"	7.	Sulphate of Ammonia	100 " " (20 ")
		Acid Phosphate	400 " " (80 ")
		Muriate of Potash	100 " " (20 ")
"	8.	Acid Phosphate	400 " " (80 ")
		Muriate of Potash	100 " " (20 ")
"	9.	Sulphate of Ammonia	100 " " (20 ")
		Muriate of Potash	100 " " (20 ")
"	10.	Sulphate of Ammonia	100 " " (20 ")
		Acid Phosphate	400 " " (80 ")
"	11.	Check	
"	12.	Lime only	2 tons Limestone Screenings
"	13.	Check	
"	14.	Lime and Manure	2 tons Limestone Screenings

All plots were manured at the rate of 10 tons to acre.

Range 2.

This range was reserved for experiments with lime.

Plot	1.	Barn	
"	2.		
"	3.	Check	
"	4.	Limestone Screenings	2,000 lbs. per acre
"	5.	Slaked Lime	1,500 " "
"	6.	Limestone Screenings	4,000 " "
"	7.	Check	
"	8.	Slaked Lime	3,000 " "
"	9.	Limestone Screenings	8,000 " "
"	10.	Slaked Lime	6,000 " "
"	11.	Check	
"	12.	Limestone Screenings	4,000 " "
"	13.	Check	
"	14.	Slaked Lime	3,000 " "

Only one crop has been obtained from these plots.

ACKNOWLEDGMENTS.

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Much credit is due Professor A. L. Gibson for carrying out the details of the arrangements of the demonstration plots, and to Messrs. S. Waterman and N. J. Thomas for carrying on this work. Mr. C. A. Cline also did good work in connection with the demonstration plots, in the laboratory and in the correlation of the mass of data gathered by previous workers. The main map and illustrations were prepared by him.

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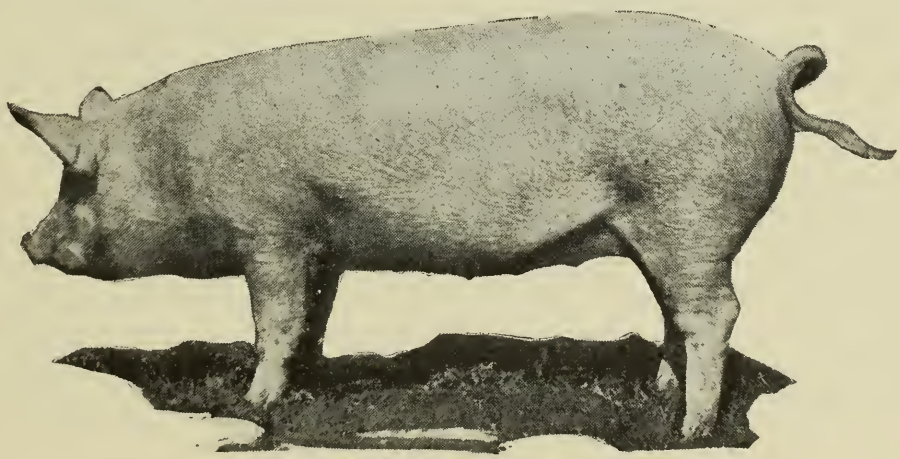
Ontario Department of Agriculture
Ontario Agricultural College

Breeding, Growing and Finishing "THE BACON HOG"

By Wade Toole, B.S.A., M.S., and R. G. Knox, B.S.A.
Department of Animal Husbandry.

Canada must produce bacon hogs or lose the export trade which makes profitable pork prices, and Ontario must continue to be the leader in bacon production in Canada. War-time prices, based upon an abnormal demand for meats of all kinds, with off type hogs going at the same price per pound as hogs of approved conformation and finish, had a very detrimental effect upon hog breeding operations. Breeders were not so careful in the selection of their breeding stock. Neither did they market at the best weights. Consequently, in so far as high-class Wiltshires were concerned, much ground was lost during



A Select Hog.
Note the length of side, smoothness throughout, trimness of jowl and underline, and uniformity of depth.

and after the war. In so far as quality and uniformity of bacon is concerned, we dropped back several decades. Conditions changed rapidly at the close of hostilities, and Canada now faces the keenest competition on the world's markets. Denmark, our strongest competitor, was almost driven out of the hog business by 1918, but is back stronger than ever and with uniformity and quality of product as well as bulk. Lard hogs may be produced at less cost in the States to the south than in this country. Cheap corn makes fat hogs at low cost. Ontario is a barley and oats province, and has the supplements

necessary to make the highest quality of bacon. Great Britain pays a premium for the long, lean bacon hog and Britain is our market. Hog prices during the past few years have ranged anywhere from two to three dollars per hundredweight higher in Ontario than on the Chicago market, and select hogs averaged $12.22 per cwt. at Toronto in May of this year as against $7.66 per cwt. average at Chicago. This is in part due to the fact that lard has been brought down in price by the enormous quantities of vegetable oils on the market, and the lard hog loses so much of his weight in fat trimmings that he is not worth as much as the more muscular bacon hog. But it must also be remembered that the demand for bacon on the British market also makes for extra money in the pockets of the Ontario hog producers. Our slogan should be: Breed the Bacon Hog.

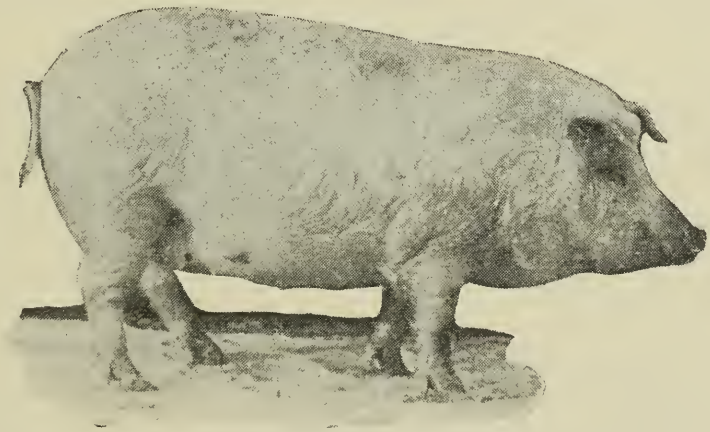
What is the Bacon Hog?

Without going into an exhaustive discussion of breeds, it might be well to consider type. Breed tests often show that there is more in type than in breed. It should, however, be understood that breeding counts, and no breeder is well advised to attempt to make over breeds when others are already established for the certain purpose he desires. Suffice it to say that in the production of export bacon best results are likely to follow the breeding of the right type of Yorkshires, Tamworths and Berkshires. It may be possible to make bacon out of Durocs, Polands, Chester-Whites and the dual-purpose Hampshires, but breeders will lose years of market profits in remaking breeds at first constituted for other purposes. It should be remembered, too, that not all Yorkshires are good bacon hogs, neither do all Tamworths make good Wiltshires, and only the long, smooth type of Berkshires get by in the "select" class. Hogs may now be sold on a graded basis, giving the producer a premium for the right kind. During the first six months of grading in Canada, only 13.3 per cent., or one hog in every eight of the 527,626 offered, graded select. The average in Denmark is 80 per cent. At the present time around 20 per cent. of the hogs marketed on Toronto market go in the "select" class. This percentage must be increased, and it is the object of this bulletin to aid in this direction.

While a large percentage of the hogs marketed in Ontario are not properly bred, many which are bred right are spoiled by improper care and finish. We must not only learn type but finish. However, type is the foundation and breeding largely controls this factor. For strictly bacon type the packer likes the Yorkshire first, the Tamworth second and the Berkshire third, but there are good and bad in all these breeds, and anyone having the type that grades "select" need not discard his breed even though it may not be the most popular. However, it is good policy, particularly for the beginner, to produce what the market wants.

The bacon hog should be long and smooth, with a nicely arched back and a straight, trim and neat underline. Length without smoothness and finish does not make a desirable hog, neither does smoothness and finish without length. The jowl and shoulder should be light and smooth, showing no flabbiness in the former and no coarseness or openness in the latter. Heavy jowls generally go with thick, fat or coarse hogs. Heavy shoulders throw the side out of balance, too large a percentage of the cuts coming from this comparatively cheap end of the carcase. The neck should be light, not too long and yet not too short and thick. The back, from neck to tail, must be evenly and well fleshed. Good bacon hogs are not razor-backs. The side should be long and

flat, carrying even with the shoulder and ham, of medium depth dropping straight from the back. No round-ribbed hogs can get in the select class. The rump should round off even with the arch of the back and should show no surplus fat at the tail head. The ham should be fairly full yet tapered nicely down to the hock. The bone should be clean and strong, and the body should show no tendency to wrinkle. The belly should be trim and neat, and the whole body should show that muscular tendency which denotes lean meat rather than fat. The pig must be finished but not over fat, and should weigh, at the market, 160 lbs. to 210 lbs., or 170 lbs. to 220 lbs. at the farm. Many a good hog is fed out of the select class by keeping him until he is overweight. Some are ruined through early pushing on heavy feed. Others go to market in an unfinished condition, and, while long and smooth, lack the finish which makes profitable killers. The Wiltshire side in greatest demand weighs from 50 to 65 lbs., and comes from the 160 to 210 lb. hog. Around 200 lbs. is the ideal weight at which to market the bacon hog and while hogs may be made up to this weight at five and a half to six months old, from six to six-and-one-half and even up to seven months may be required to make choicest bacon. At the Ontario Agricultural College choice bacon hogs are brought up to 200 lbs. at from six to six and one-half months. Hogs finished too young lack length and muscular development. Those held back until too old are coarse, soft and undesirable killers. Good bacon hogs are long, smooth, trim, neat and muscular, which means strength of constitution but not a round fat belly, and which also means the proper proportion of lean to fat and not a surplus of the latter for the lard kettle. The accompanying illustrations show the right and wrong kinds alive and the desirable and undesirable sides when hung.



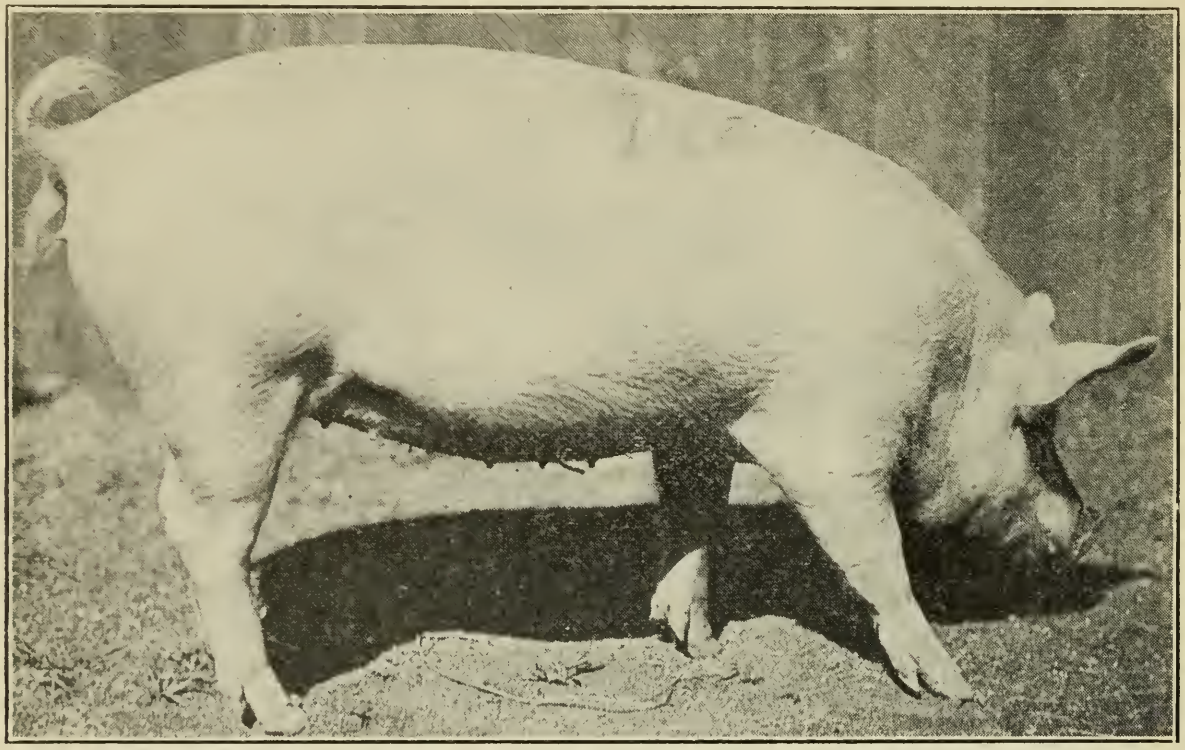
An Undesirable Type.

A thick smooth, side short, jowl and underline heavy, ribs round; a typical fat back, lard type hog.

Producing Bacon.

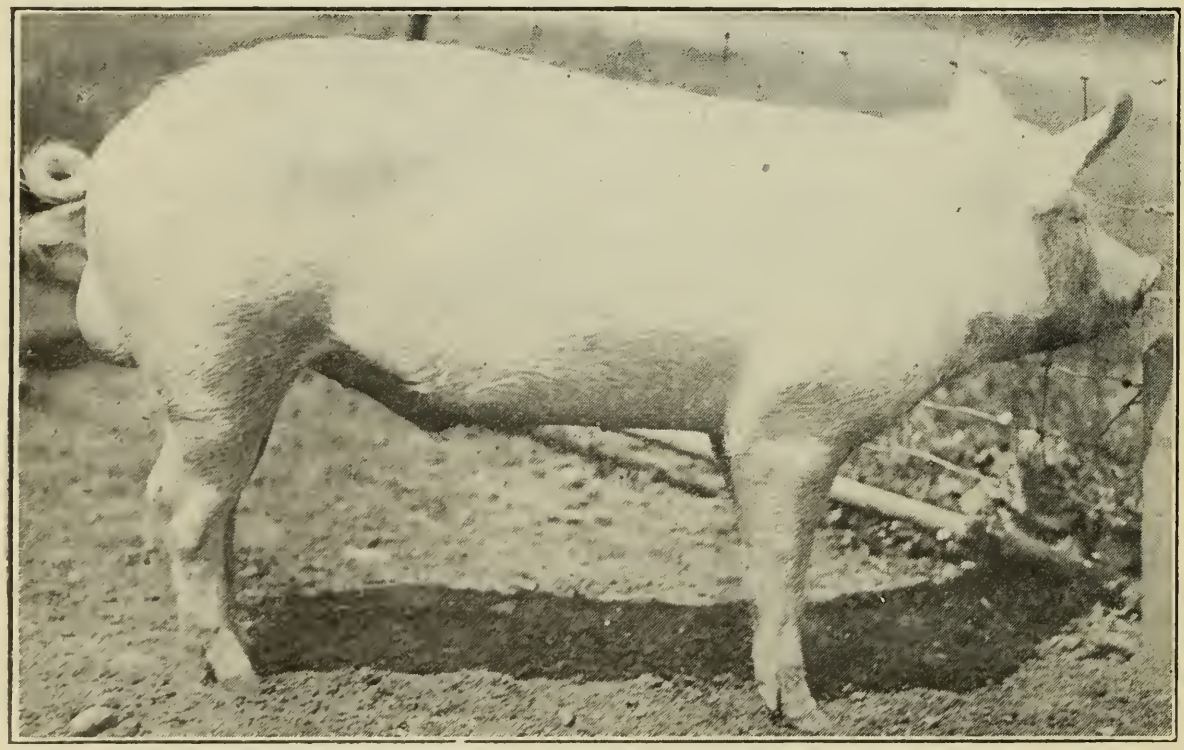
Good bacon hogs may be produced either in summer or winter. Of course, it requires less expensive feed and care in the summer. The strength of the litter depends in no small degree upon the care of the sire and dam. If possible, breed only from a boar of outstanding bacon type himself, and perferably one out of a large even litter with generations of bacon type behind them. The same holds true of the sow. Uneven litters are one of the chief causes of lack of uniformity in product. Thrifty pigs are often held too long, or runts are sold before properly finished. Boars should get little or no service until well grown at eight or nine months old and then only a few sows. Sows if they are to get the best size and become the best producers should not be bred until they are

eight months old and well grown for their age. Exercise for boar and sow is absolutely essential. The boar should have outdoor exercise in a paddock for from five to ten hours out of each twenty-four hours winter and summer, and



A Good Type of Young Breeding Gilt.

This eight months' old gilt shows the proper proportions to make an ideal brood sow for the production of bacon. Owned by Ont. Agr. Coll.



Eight Months' Old Boar.

This young hog is the type from which to produce bacon hogs. He is out of an even litter of 16 pigs. Note length, smoothness, balance and general conformation. Owned by Ont. Ag. Coll.

the pregnant sow should have the run of a pasture paddock or field in summer and the barnyard or other paddock in winter. Litters depend upon exercise of the parents. Neither boar nor sow should be kept fat. Thrifty condition means good condition. For the boar, ground oats, wheat middlings and a little barley makes a good ration. With this he should get some mangels or sugar beets in winter and some clover, alfalfa, peas and oats or rape for green feed in summer. Skimmilk and whey are always good. In fact, barley and oats mixed makes a good grain ration if it is balanced with skimmilk, whey, clover or alfalfa. The following table shows results with winter feeding of the College boars:

Winter Maintenance of Boars.

Boar	Age	Weight	Feed per day	Gains	Cost of feed per day	Cost of feed per 100 lbs. live weight	No. of services
Tamworth.....	10 mos.	285 lbs.	chop, 6.33 lbs. whey, 16 lbs. mangels, 3 lbs.	91 lbs.	11.6 cts.	3.1 cts.	4
Yorkshire.....	2 yrs.	446 lbs.	chop, 6.51 lbs. whey, 16 lbs. mangels, 2 lbs.	40 lbs.	11.5 cts.	2.5 cts.	17
Old Yorkshire..	5 yrs.	485 lbs.	chop, 6.51 lbs. whey, 16 lbs. mangels, 3 lbs.	19 lbs.	11.9 cts.	2.4 cts.	10
Berkshire.....	2 yrs.	615 lbs.	chop, 6.3 lbs. whey, 16 lbs. mangels, 3 lbs.	14 lbs.	11.5 cts.	1.8 cts	9

Chop—equal parts barley and oats by weight, $1.40 per cwt.
Whey, 12½ cts. per cwt.
Mangels, 15 cts. per bushel.
Nutritive ratio, 1:7.
Average daily cost, 11.6 cents.

Ground oats should form the basis of the ration for the brood sow. If middlings can be added up to 30 or 50 per cent., so much the better. Barley may be used as a part of the ration, but preferably not more than one-third and never more than one-half. Corn, if used, should not constitute more than one-third the ration, and preferably with one-third oats and one-third shorts or middlings. Sows should summer on alfalfa, red clover, sweet clover, peas and oats or rape with little grain. Skimmilk, buttermilk and whey are always valuable for the brood sow.

It is not the object of this leaflet to go into detail on feeding and management of breeding stock. Keep in mind exercise, and feeds intended to produce bone and muscle, not fat.

Feeding for Bacon.

Pigs intended for bacon should nurse from six to eight weeks. At the Ontario Agricultural College all litters are left with the sows until they reach eight weeks old. Weaning is done gradually, and there is no better feed than

skimmilk and middlings with which to start the newly weaned pigs. However, finely ground oats and middlings are often used, and even a mixture of one-third middlings, one-third finely ground oats and one-third barley is often used to good advantage. In the making of bacon it must be remembered that the right type of pig may be ruined by heavy feeding on barley, corn and other heating and fattening feeds just after weaning and before he is properly grown. Rations should be made up with the idea of promoting growth rather than finish. The best growing feeds are: middlings, shorts, finely ground oats, skimmilk, buttermilk, whey, tankage (alfalfa, red clover, green), rape and roots. The bacon hog must be grown first, then finished. Heavy feeds too early in life tend to round the rib, shorten the side and lay excess fat on the back and ham as well as make for a flabby jowl and a wasteful middle. Many well bred hogs of good type are spoiled by early pushing with the wrong kinds of feed. Middlings, oats, milk, whey, tankage, and the clovers are high in protein, and so build bone and muscle rather than fat. Exercise helps to build muscle also, and should be freely given to young pigs. Generally speaking, it is well to grow the pigs until they are four-and-one-half to five months old and then finish them as quickly as possible by gradually adding barley in place of middlings, a good finishing ration being composed of two-thirds barley and one-third finely ground oats. If skimmilk is not available, tankage up to 8 or 10 per cent. in the ration will prove profitable, particularly in winter feeding. The plan should be to grow the pig before he is finished, and to finish under 220 lbs. at the farm. The all too prevalent idea that pigs make cheaper gains when around 200 lbs. is erroneous. Pigs, like all other animals, make most economical gains when young. It does not pay to hold them over the market weight, either in gains or in market price. Once over the 210 lbs. at the market and they are docked $1 per hundred pounds. All young pigs should get exercise, and, in summer, green feed will reduce the cost of pork production up to nearly 25 per cent. All pigs should have mineral matter. The following has given good results at the O.A.C.: Four bushels charcoal or wood ashes, 8 lbs. salt, 2 quarts of air-slaked lime and 1 lb. sulphur. Place this in a box in a corner of the pen. The addition of a little bone-meal would doubtless improve this mixture.

Chief Causes of Pigs of the Right Type not Grading "Select."

1. *Overweight.*—Over 210 lbs. at the market. Fed too long, possibly waiting for a rising market. Feeder loses out because they sell for $1 per cwt. less and do not make as economical gains as are made under 200 lbs.

2. *Heavy feeding* just after weaning. Pigs pushed on heavy fattening feeds such as barley, buckwheat and corn too soon after weaning. Pigs must be grown on protein-rich feeds and finished later.

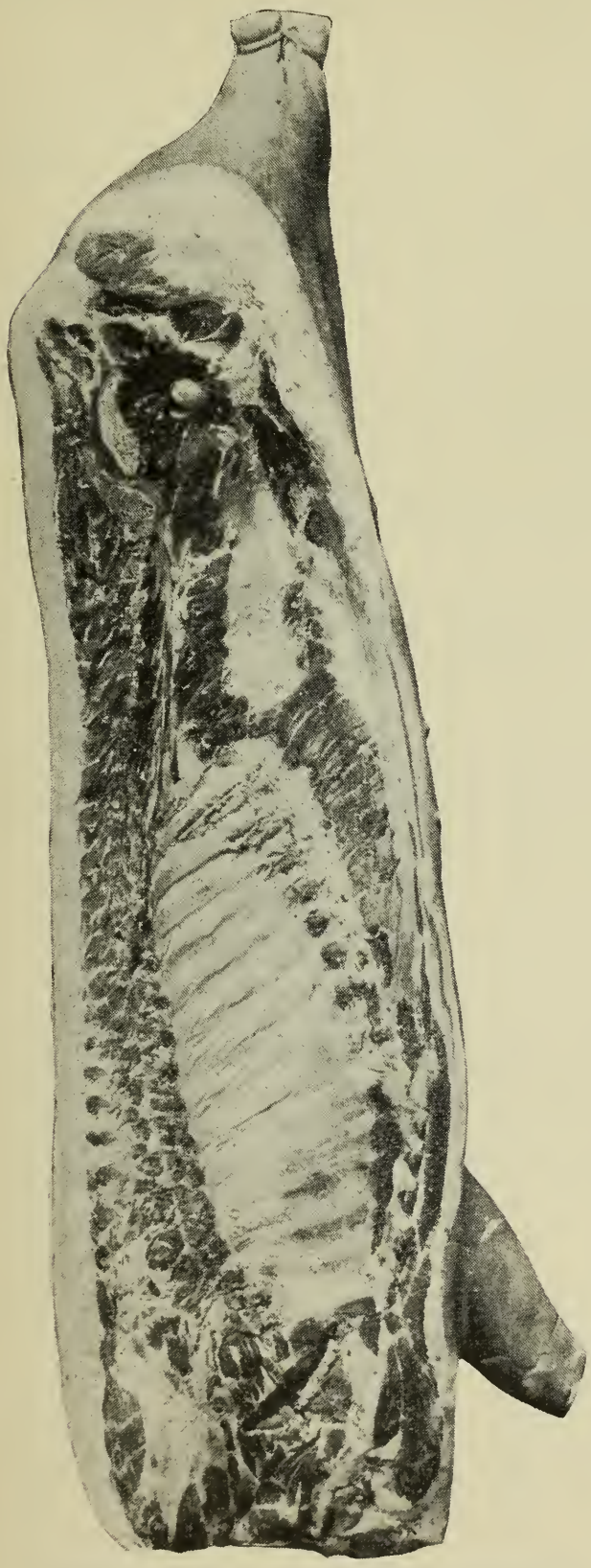
3. *Poor feeding.*—Pigs starved or stunted in early life or held until old, coarse and rough before they are up to market weight. Generally soft in carcase and coarse in texture.

4. *Under finish.*—Pigs not finished to the desired 1¼ inches of fat down the back, generally through lack of feed or a mistaken idea of what the finished bacon hog really is.

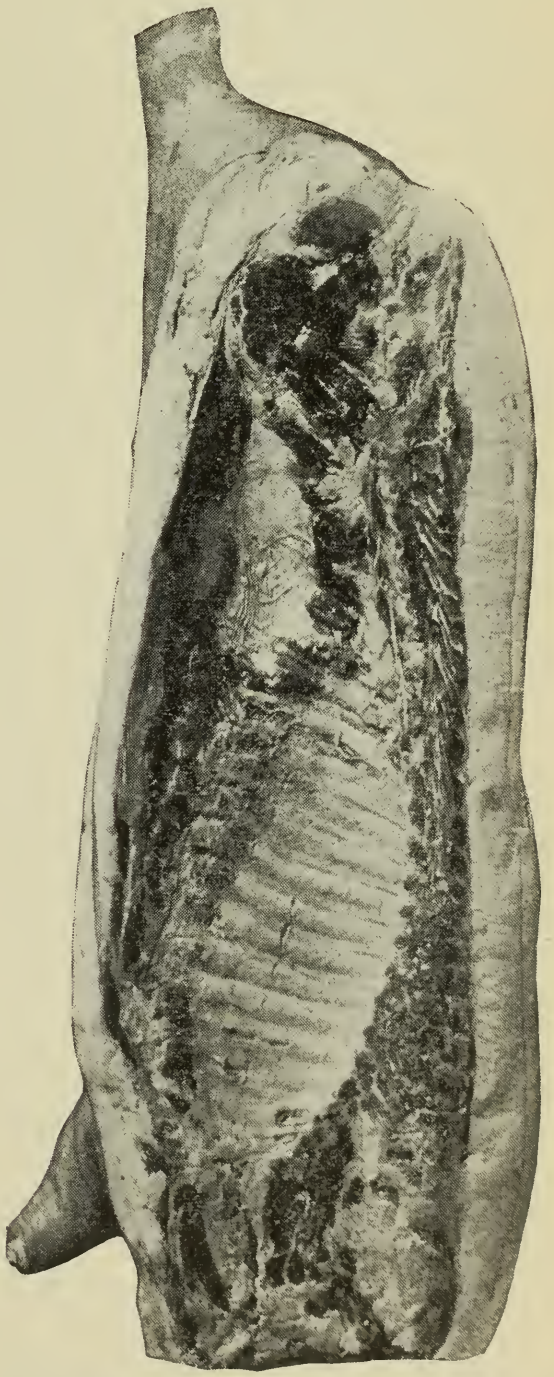
Softness in Bacon.

Softness is one of the chief causes of loss in Canadian bacon. All soft bacon sells at a discount. Pigs fed heavily in early life, particularly on fattening feeds, and at the same time closely confined in pens without exercise produce

a soft bacon. Experimental work at the O.A.C. has proven this fact as well as that pigs grown to 100 to 125 lbs. weight on mixed feeds well balanced with skimmilk (about 2½ lbs. milk to 1 lb. of meal) or tankage up to 10 per cent.



"Wiltshire" side from a select bacon hog. Note the length, evenness of finish and uniformity.



"Wiltshire" side from hog of lard type. Too short, too fat, and too heavy in front.

in the ration may be finished on corn or barley and still produce a firm, high-quality product. Close confinement in pens from weaning until marketing has a tendency to produce a soft, flabby product. Dairy by-products tend to

offset the trouble arising from lack of exercise, but both exercise and skimmilk are better than either alone. Unthrifty hogs and all unfinished hogs as well as hogs carried too long on a maintenance ration to keep them from becoming too heavy while holding for a rise in prices generally kill out soft carcases of lower than select grade.

Feeding corn alone for an extended period produces poor gains and a soft, undesirable carcase. Barley and oats produce a firm, satisfactory bacon. Extensive experiments show that roots and green feed, including pasture, clovers and rape, have no injurious effect upon the quality of the bacon.

In summer finishing, for the last month or so, more rapid gains are made where green feed is carted to the pigs inside as compared with allowing the pigs to graze, but it takes just about double the work.

Marketing immature, unfinished pigs should be discouraged. They kill a low percentage carcase and are generally soft and so do not grade select. Unthrifty hogs generally produce soft carcases. Exercise and thrift go together, and thrift and firmness are inseparable.

Feeding on meal and meal alone has a tendency to produce soft bacon. Mixed feeds are safer than exclusive meal rations.

Beans produce soft pork. Buckwheat fed alone has a similar tendency. Fed in a mixed ration, it is all right and gives good gains. Certain oily by-products should not be fed in large quantities but only as a small portion of the ration.

Exercise, rapid growth from weaning up to the finishing age on a mixture of feeds, and a satisfactory degree of finish evenly distributed make for quality of product. Starving, stunting, holding, crowding with heavy feed when young, lack of variety in feed, holding for a higher market all make for a low-grade product.

Feed to Produce 100 Pounds of Gain.

Many feeders still believe that it costs more to put a pound of gain on a bacon hog than upon a lard hog. This is not correct. The right kind of bacon hog will make gains as cheaply as the lard hog breeds. Some years ago a series of experiments were conducted at the O.A.C. with six different breeds of swine, and the following table shows how they stood in each of five years as to economy of gains:

1st year	2nd year	3rd year	4th year	5th year
1. Berkshire.	1. Berkshire.	1. Yorkshire.	1. Berkshire.	1. Berkshire.
2. Tamworth.	2. Tamworth.	2. Berkshire.	2. Tamworth.	2. Yorkshire.
3. Poland China.	3. Poland China.	3. Duroc Jersey.	3. Yorkshire.	3. Duroc Jersey.
4. Duroc Jersey.	4. Chester White.	Tamworth.	4. Chester White.	4. Chester White.
5. Chester White.	5. Yorkshire.	4. Chester White.	5. Duroc Jersey.	5. Tamworth.
6. Yorkshire.	6. Duroc Jersey.	6. Poland China.	6. Poland China.	6. Poland China.

This table shows that the bacon breeds held their own. Moreover, the Yorkshires stood first over the period of five years as to suitability for export bacon, with the Tamworths second and the Berkshires a good third. The other three breeds proved unsuitable for the export trade.

Last winter a similar experiment was started to be run again for five years. It was a hog finishing test, the pigs weighing 136 lbs each at the start.

The following table shows the results in brief:

Breed	Lbs. grain per cwt. gain	Grade	Profit
Yorkshires	417	2 select. 1 thick smooth.	$6.67
Berkshires	397.8	2 select. 1 thick smooth.	5.52
Tamworths	406.3	2 select. 1 thick smooth.	3.56
Durocs	387.4	3 thick smooth.	4.79
Polands	476	3 thick smooth.	5 cts.

NOTE.—Tamworths were marketed at an earlier age than others consequently one was unfinished and none was quite as well finished as the other breeds. Three pigs in each lot.

Ration equal parts of barley and oats and 8 per cent. tankage.

With good feeding it requires around 400 lbs. of meal or its equivalent to produce 100 lbs. of gain, and the big thing to remember is that there is very little difference in cost of gains with the various breeds, but there is a difference in grade of product which means more money for the kind that grade select.

STANDARD RATIONS FOR BACON HOGS.

Breeding Boars

Equal parts barley and oats (ground).

2½ lbs. whey or skimmilk per lb. grain.

2 to 3 lbs. mangels or sugar beets.

For summer—Green alfalfa, red clover or peas and oats may take place of roots and milk.

Tankage may be used up to 8 per cent. in place of skimmilk or whey in winter. Or oilcake meal may be used in about the same proportion. If no skimmilk or tankage available, use middlings one-third of ration.

Feed the amount they will clean up in 15 minutes.

Breeding Sows (Dry).

Equal parts barley and oats (ground).
1 lb. per 100 lbs. of live weight.

Whey 4 lbs. per 100 lbs. live weight.
Skimmilk, 2 lbs. per 100 lbs. live weight, or
Shorts or middlings, one-third the grain ration.

Roots, 2 lbs. per 100 lbs., live weight.

Cured alfalfa or red clover, all they will eat in winter.

In summer 2 lbs. of grain mixture per sow per day when on pasture of clover or peas and oats.

Breeding Sows (Nursing).

For a 450 lb. sow:—

Oats and barley (ground) equal parts, 7 lbs.

Middlings..... 3 lbs.

Skimmilk.....22 lbs.

Roots..... 7 lbs.

Ration when pigs are young increasing to 15 lbs. grain as the litter grows older.

Corn or buckwheat might be used as one-quarter the ration in place of barley.

Whey, tankage, or oil cake, could take the place of skimmilk.

In summer, green clover, alfalfa, peas and oats or rape would largely take the place of skimmilk and roots.

Rations for Market Hogs.

Weanling Pigs up to 75 lbs.

No. 1.—Equal parts of finely ground oats and wheat middlings.
2½ lbs. of skimmilk or buttermilk to 1 lb. meal.
If skimmilk not available, 8 to 10 per cent. tankage.
(About 1 lb. tankage to 9 or 10 lbs. meal.)

Growing Pigs, 100-150 lbs.

No. 1.—Barley and oats (ground), equal parts.
Skimmilk, 2½ lbs. to 1 lb. meal.
Or
Tankage, 8 per cent.

Weanling Pigs up to 75 lbs.

No. 2.—3 parts finely ground and sifted oats.
1 part low grade flour.
Skimmilk or tankage as in No. 1.

Growing Pigs, 100-150 lbs.

No. 2.—3 parts ground oats.
2 parts ground corn.
Skimmilk or tankage as in No. 1.

Growing Pigs, 75-100 lbs.

No. 1.—2 parts finely ground oats.
1 part ground barley.
1 part wheat middlings.
2½ lbs. skim milk to 1 lb. meal.
If skimmilk not available, 8 per cent. tankage.

Finishing Pigs, 150-200 lbs.

No. 1.—1 part ground oats.
2 parts ground barley.
Skimmilk, 2 lbs. to 1 lb. meal; or
Tankage, 8 per cent.

Growing Pigs, 75-100 lbs.

No. 2.—2 parts finely ground oats.
1 part ground barley.
1 part low grade flour.
Skimmilk or tankage as in No. 1.

Finishing Pigs, 150-210 lbs.

No. 2.—2 parts ground oats.
3 parts ground corn.
Skimmilk or tankage as in No. 1.

Note.—In feeding all market hogs, rather than give actual amounts of feed per 100 pounds live weight, the writer prefers just the amount they clean up well in 15 minutes. Amounts vary with different litters but the 15-minute period is a safe guide.

Where skimmilk is not available, tankage is a fair substitute, but should be fed with care. It should be well mixed with the grain and should be fed in very small amount at first, gradually increasing up to 8 or 10 lbs., in 100 lbs. of the meal mixture. Too little may not balance the ration and so would prove unsatisfactory. Oil cake meal may be used in place of tankage. Where green alfalfa or red clover or peas and oats or rape are available, skimmilk, tankage or other protein-rich feed is not so essential. Roots in winter may be used to good advantage in the ration of the growing pig. They may be fed in equal weight with the meal. Feeds not mentioned may be worked in, but the materials stressed here should form the basis of the ration.

Skimmilk, tankage or oil cake is not absolutely necessary in the ration for the finishing pig but a little may be used to good advantage.

If corn is used in any large amount in the feed, skimmilk, tankage, oil cake, green alfalfa or some other protein-rich feed is necessary in abundance.

No attempt has been made to exhaust the available feeds. The foregoing rations will give an idea of the kind of ration required.

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BULLETIN 300] [JULY, 1923

Ontario Department of Agriculture

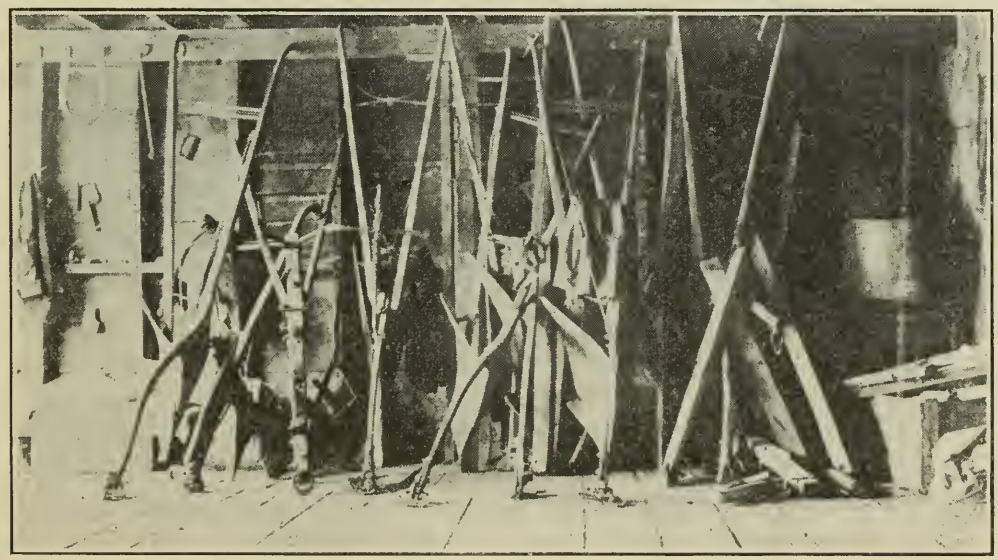
ONTARIO AGRICULTURAL COLLEGE

The Care of Farm Implements and Tools

By L. Stevenson, B.S.A., M.S., Director of Extension.

With the advance of agriculture the increase in farm tools, implements and machines has been great. A century ago, an axe, a scythe, a spade and a saw formed a large part of the equipment of many farmers. These few simple tools were probably the most useful in working the small areas of land under process of clearing. The development of the farms brought improvement in tools and a gradual development toward the modern type of farm machines.

Tools were valued in the early days because such were hard to get. There was no waste of farm equipment then; the spade and the scythe were valued as much as the shot gun. Conditions have changed during the past century; the progress is now marked by an abundance of tools, implements and machines



The way a thrifty, Scotch bred farmer stores his implements—no waste, no lost time, full efficiency of the implement, everything in its place, work goes on with despatch and no annoyance.

for every purpose in agricultural production and harvesting, an abundance of machines so great that we see waste on every hand; plows, tillage machines, and harvesters neglected and exposed to the weather, rust and wear out before giving half service.

The waste of tools, implements, machines and articles of farm equipment amounts to many thousands of dollars each year. Neglect to put machines

under cover, to apply weather proofing paint, to keep sharp all cutting parts, to oil or otherwise lubricate all bearings is reducing the efficiency and shortening the period of usefulness of equipment in which many millions of dollars of farmers' money has been invested. The machine or tool is not the only loss, since the power, either of horse, motor or man is also reduced through having

A good plow being neglected. It may be nearer the work when the snow is gone and spring work starts, but its condition for good work is doubtful. Implements when stored in a dry shed where repairs can be made during the period of idleness, and where protected from weather, will be ready for the field and do good work on the opening day of spring. The plow that spends the winter in a snow bank generally has a rusty mould board, a dull point, loose handles and no clevis.

to work with a tool or implement not in the best condition. This double liability, while fully appreciated by the most efficient or business type of farmer, is a matter that should be appreciated by all who own or work with farm tools.

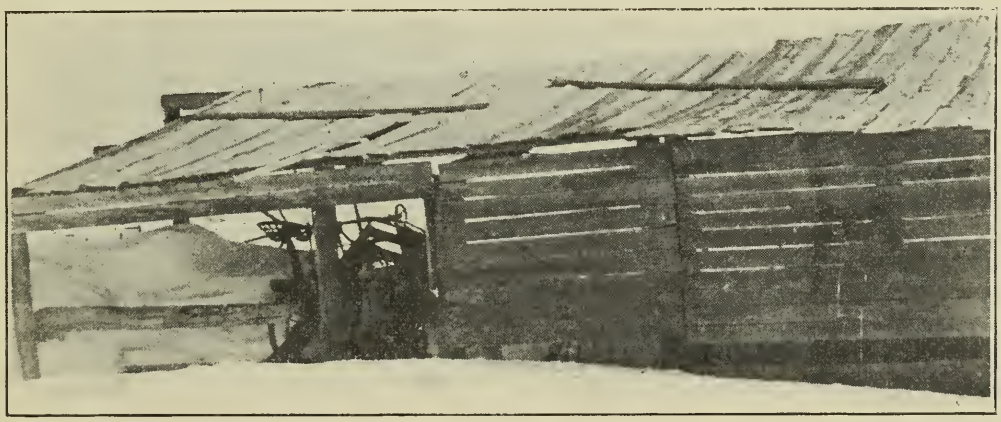
In the hands of good men a grain binder has been known to last and do 100 per cent. efficient work for thirty years. In the hands of careless men, grain binders have been known to have been racked to pieces in less than five years through such treatment as neglect to oil and keep bolts tight. The reward for efficiency might here be expressed as the saving of the price of five binders over a period of thirty years.

The waste of implements noticeable over the country side at all seasons of the year is to be seen on every side. In the winter plow handles are noticed sticking up out of the snow, or the hayrake or seed drill, half buried in a snow bank along some distant fence row, or beneath a tree, tell of somebody's neglect. At the Provincial Plowing Match and Farm Machinery Demonstration held in 1922, one of the winning plows was an implement imported from Scotland

early in the last century and had seen seventy-five years of service on Ontario farms. This plow had turned thousands of acres of land. It is still sound and good for many more years. Some men will wear out and break up a good plow in five years. If good care on the part of a thrifty Scotsman will keep a plow in good form for a century, and make it earn its costs over and over again, it should be a good practice for every farmer to follow.

The Binder.

The grain binder or modern harvester is a complicated machine with many moving parts, requiring careful adjustment and constant care if it is to give the best service and last. Every binder operator should know his machine sufficiently well to produce perfectly formed, well-tied bundles of grain. Perfect sheaf or bundle making begins with the delivery of the standing grain to the knife and platform. In this the reel plays an important part; if properly adjusted for height and distance forward, the grain will fall evenly and will be carried in like condition to the packers and binding attachment. With the reel improperly adjusted, the grain may fall forward or it may be scattered on the platform. Once scattered, it is impossible for the conveyers or packers to straighten it out, to the degree necessary for perfect sheaves. Careful watch should, therefore, be kept on the reel and adjustments made while the machine is in motion to meet the conditions caused by lack of uniformity in the crop. The grain passing from the conveyers or elevator is next adjusted by the butting



A poor attempt at storing implements may be better than nothing at all. It at least indicates that intentions are good. The $300 binder should be worth taking care of. Only the very rich farmers can afford to neglect their implements. And no farmer is so poor but that he could provide better protection than the above picture indicates. Those that have not the will to take care of their implements must keep on buying.

attachment and the packers. The binder table or the butting attachment can be shifted to meet the needs of long or short grain and the binder operator must be alive to the making of the necessary adjustments or the bundles will not be of a desirable shape and tightness. The binding attachment with its twine run needle and knotter will give highly efficient service if given reasonable attention by way of oiling and proper adjustment. The binding attachment parts rust very easily during periods of idleness, so liberal applications of a heavy mineral oil or grease to all parts not protected by paint will save the machine, will save time, labour, and temper. Rust can be removed by sandpaper, but harvesting machines were never intended for such treatment. The wooden slats that form an important part of the canvas conveyers will sometimes tear loose. This is

caused by the frame and rollers not being in proper alignment or square. This difficulty is overcome by adjusting the cross braces of the frame until it is square and the rollers in alignment. The power for operating the various parts of the grain binder is transmitted by chain and sprocket, the various units being provided with tightness. If the various chains are not run at proper tension, trouble will follow. If too tight the links will break, or the draft will be heavy. If too loose the machine will be driven with a jerky motion. If the chains are just slack enough so such can not be taken off by hand when the machine is not running, they will usually be satisfactory when in motion. Chain links and sprockets should be well oiled at all points of contact. Missing sheaves or failure to tie the bundle is a common trouble, usually due to the operator's failure to make the adjustments necessary to give full efficiency to the tying mechanism. If the needle fails to carry the twine far enough over that it may be grasped by the twine disc, a knot will not be tied, since but one end is held. This condition is generally easily recognized by the twine being knotted in a loop at one end the other end being free. When the twine disc is held too tight by the clamp and spring, it will in turn hold the twine so tight as to pinch it off and cause a failure to tie. This condition is generally indicated by one end of the band being frayed. The loosening of the spring that holds twine disc will remedy this fault. If the twine disc is loosened too much, the knot cannot be tied; this condition is generally indicated by both ends of the twine band being frayed. Another cause of failure to tie is often found in the knotter spring which holds the finger down upon the knotter hook being so loose as not to hold the ends of the twine while the knot is pulled over the billhook, resulting in a band with clean cut ends but no knot, the adjustment, through wear or lack of adjustment through shaking loose of the bolt holding the twine cutting knife, causing the severing of the twine before the knotter finger or billhook has closed over it. Binders that have been subjected to rough usage so that either the needle or the shaft on which it works becomes bent or out of line to such an extent as to prevent the needle putting the twine immediately over the notch in the twine disc will make loose or untied bundles. A rusty needle, billhook, twine disc or twine runs will cause no end of trouble early in the harvest through loose or missed sheaves.

Oiling the grain binder takes considerable time with fifty or more oil holes to keep clear and supplied with oil. There are bearing surfaces other than oil holes that must receive attention also, such as the reel standard, various chains and sprockets, sliding parts of the binding attachment and the bundle carrier. All bearings subject to heavy friction and speed should be oiled every hour if the binder is to last as long as a binder should last. Every bearing should receive lubrication at least twice a day no matter how little work the bearing does. The main drive bearings, the pitman, and the sheaf binding attachment require the closest attention. Where oil cups are provided, these should be supplied with a packing of wool or cotton wadding to hold and aid in proper distribution of the oil to the bearing. A fairly heavy mineral oil of good quality, similar to the best grades of motor oil, is the best lubricant for the grain binder. An oil can with a long flexible spout and also a good oil hole pick should be in the binder tool box. There are several hundred bolts to keep tight. The great majority require no attention, but there are some that work loose and need watching. The operator who knows his machine can detect anything out of order by sound, and will at once locate the trouble. Bolts that loosen should be supplied with split spring washers or cotter pin nuts. It is a good plan to look the binder over carefully every morning, and again when starting in the

afternoon, while oiling. Efficiency in keeping the machine in good condition will come with experience, providing the operator is one who can learn and profit by experience. With some men the grain binder is ready for the scrap heap in five years; with other farmers it will last thirty years. A canvas cover large enough to protect the machine from sun and rain should be part of the grain binder equipment. At the close of the harvest season the harvester should be cleaned thoroughly and all moving parts oiled. The needle and the guides through which the twine travels should be greased. The knife should be taken out, dried and wiped over with a cloth soaked in oil and then put away. The canvas conveyers should be thoroughly dried, rolled up and put away in dry storage. The binder should be packed away in the barn or implement shed out of the way. Don't let the chickens use it as a hen roost; a few poles would be cheaper and serve the hens just as well.

The Mower.

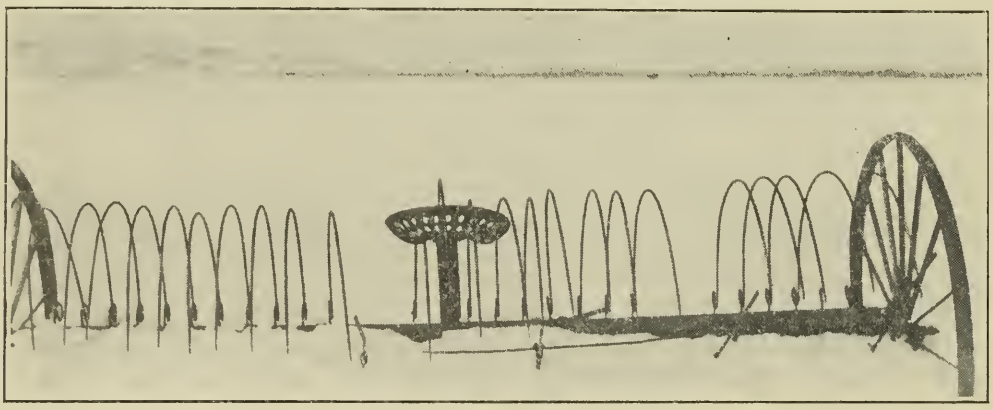
This machine has given splendid service to the farmers of the past and present generations. Fifty years ago the mower was a perfected machine and the improvements since that date have not been of a revolutionary nature. This machine is subjected to a number of abuses, traceable to the carelessness of the average farm hand; lack of attention in oiling; and dull ledger plates and knife operated over rough or stony ground. With the knife running close to the soil surface, injury from contact with gravel, sand and small stones is frequent. The watchfulness of the operator to avoid subjecting the cutter bar to injury is the best protection when the mower is in use on rough ground. The cutter bar with its numerous guards can be elevated or tilted quickly by an experienced operator and obstructions avoided. The guards should be kept tight and in perfect alignment. The small steel plate that is riveted to the guard at the point where the knife edge performs the scissor movement should be kept sharp or at least not permitted to wear round. These plates, commonly known as ledger plates, become dull with use, a condition that greatly reduces the efficiency of the mower and increases the draft. A mower with dull or rounded ledger plates will stick in heavy cutting or damp grass. A sharp knife and sharp edged ledger plates means light draft for the team and clean, free cutting of the crop. Too much attention cannot be given to the cutter bar with its attached guards and quick moving knife. If the mower sticks at every mouse-nest or tuft of grass, the place to look for the trouble is in the dull knife, the ledger plates, the worn guards, or the keepers that hold the knife down in place. With the new mower it will be noted that the cutting edges are sharp, that there is but little play for the knife other than as intended. In the past too little attention has been given to keeping the ledger plates sharp. With these dull, no matter how good the knife is, tough material will be drawn beneath the knife and ledger plate instead of being cut, forcing the blade up against the guard causing wear that gives a loose fitting knife, poor work and greatly increased draft.

The experience of all is that the mower cuts better the first season than ever after. This experience is largely due to the fact that too little attention is paid to the parts that are responsible for the cutting. The wear on the section points of the mower knife is greatest near the point. This wear, together with the grinding necessary to keep the knife sharp, changes the shape of the section considerably and in such a way as to reduce its efficiency as a cutting implement. The man doing the grinding should endeavour to keep the original shape of the section in so far as possible. Many of the emery grinders used in sharpening

mower knives grind away the points of the section to a serious extent without doing very much sharpening. A specially shaped emery or carborundum stone or file should be used and the work done in the farm shop. A spare knife should always be at hand in the field. The mower should be gone over carefully twice each day and all bolts tightened. The main bearings should be oiled at least once each hour; the pitman bearings at least every half hour. When the mower is not in use the knife should be removed. The cutter bar should be elevated to the vertical position when the machine is not in use. A little heavy mineral oil should be brushed over all parts that are likely to rust. Don't use paint oils. The mower, like the binder, to give its best service, should be given good care.

The Rake—Sulky.

Under modern farm practice in Ontario with alfalfa, sweet clover and red clover making up a very large percentage of the hay crop, it is an advantage to have a rake possessing the following points. Teeth made of a good quality steel, one half inch in diameter, round in cross section, two coils for elasticity and shaped with a chisel point. The teeth should not be spaced over five inches apart. A strong slightly flexible clearing rod should be fitted to function between



It will take four loads of good hay to replace this neglected rake. A hay rake if given good care will do the raking on 100 acres for 30 years. Neglect it as is pictured above and we will have to go down in our pockets for the price of a new one every five years.

every fifth tooth. The sulky rake, to last well and give good service, should be given protection when not in use, and not left under a tree or in the fence corner from June to October. Oil daily the main axles and other parts where friction exists at least once each day.

The Rake—Side Delivery.

The side delivery rake has come into general use and to a large extent replaced the sulky rake on many farms. Its popularity is partly due to the dual purpose service that may be had from this type of a machine. There are several types of side delivery rakes in use, the revolving fork and the reversible. The revolving fork is the most common type and it is generally satisfactory in making all varieties of hay excepting those being made from long grasses. The difficulty with its use is the tendency to roll grass into a rope-like windrow. The reversible type of side delivery rake is to be preferred in the making of grass hays. There is a good deal of strain and vibration in the

operation of the side delivery rake which calls for close attention in oiling, keeping bolts tight and preventing the winding of hay on the end of cylinder bearings. The side delivery rake does its best work on smooth level lands that are free from stumps, deep furrows, or ridges. Protection to prevent rusting and weathering is very essential to this machine.

The Hay Tedder.

The hay tedder is very necessary in the curing of heavy clover, and performs a very useful service in hastening the circulation of air through the green hay which it picks up after the mower and throws into a loose fluffy mass, a condition favourable to quick curing. There is considerable vibration and jig to contend with in the tedder, conditions which make careful adjustment and oiling very essential to its period of usefulness. The gears and sprockets together with the bearings of the main axle and drive shaft are the principal points requiring attention. These should be oiled every hour. Strong winds blowing in the direction that the tedder is travelling, interferes considerably with the work, and time may be gained by tedding one way. Hay winding on the bearings should be removed at once. A strong sharp knife, a wrench and an oil can should be in the tool box.

The Hay Loader.

The modern hay loader being a large cumbersome machine is frequently subjected to neglect and exposure. This condition is due largely to the little additional trouble in handling a large machine in storage. The structure of the hay loader is such as to demand protection from weathering to all parts when the machine is not in use during the haying season. There are two types of hay loaders in general use, the endless apron loader and the fork loader. The endless apron loader handles clovers more gently than does the fork loader. This is an advantage in that there is less loss of leafy material. The fork type of loader will deliver the hay farther forward on the load and does not drag back and drop part of the hay as its sometimes noticed with the endless apron type.

The drive gears should be kept free from winding bits of hay. Oil for the main axle bearings and for the upper end of elevator bearings is very necessary. Care should be taken to see that all slats are parallel, that tooth and fork bars on the cylinder or fork standards are tight, true and in proper alignment. Ropes and chains should be kept at proper tension and adjustment made following damp weather if necessary. The loader should be carefully gone over twice each day, oiled and adjusted. A supply of repair parts and tools should be at hand in the hay field, so that repairs can be made quickly. The working of hay loaders over rough ground, across deep furrows or under trees generally has to be followed by an experience in making repairs.

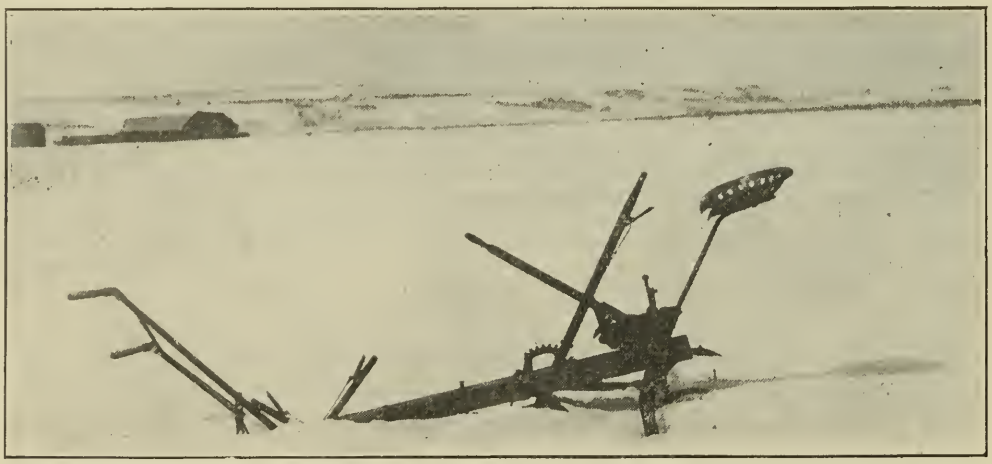
Care of Plows.

When the plow is not in use its bright surfaces should be protected by a layer of thick mineral oil or grease. Heavy machine oil or good axle grease rubbed over the mould board, share, coulter and jointer point will save a plow from the ravages of rust. The rusting of one winter period may injure a plow more than a long season's service in the field. Rusty plows lose a lot of time for man and team in the spring, through delay caused by halts to clear and

scrape a mould board that will not scour. All braces and bolts should be kept tight, the points of share, coulter and skimmer sharp, and of proper shape. The plow wheel and axle should be kept well lubricated and packed in such a way as will prevent sand reaching the wearing surface of wheel hub or axle. The small wheel of a plow will turn 40,000 times in a day plowing two acres. If the wheel is to last and do good service, the axle should get a little heavy oil every hour. An oil can holder should be attached to every plow, so that the oil supply will always be at hand and screeching prevented by its timely use. If the plow point becomes worn the inclination of the mould board is changed; the plow tends to run on the point, the work becomes heavier on both the horses and the plowman, and poorer work is done. The heel of the share wears nearly as quickly as does the point. With the dulling of the heel the plow will wing over to the land and require more exertion on the part of both man and team. Keep the plowshare sharp and in proper form. A coat of paint applied to the handles, beam and all other parts that do not come in direct contact with the soil will do much to keep up appearances and prevent weathering.

Harrows.

The iron smoothing harrow, being a rather clumsy implement to handle, is apt to be neglected to the extent of bolts working loose and teeth falling out. A small wrench should always be at hand, preferably strapped to the adjusting lever, with which all bolts could be tightened and kept in proper adjustment.



The cost of neglect to provide shelter can be measured by the frequent replacement cost for new implements.

The teeth should be kept sharpened if the harrow is to do its best work with the least expenditure of horse or tractor labour. The harrow sections should be tested for uniformity of set frequently, by lining up the teeth and seeing that all are cutting the same depth. Long, short, crooked, or dull teeth reduce the efficiency of this implement. When not in use the harrow should be piled in sections out of harm's way. In storing away after seeding it is a good practice to daub a little machine oil or grease on the bright portion of each tooth, using a brush or cloth to do so. If any parts, such as bolts or teeth have been lost, make note of it on a card, tying the card to the section so that repairs will be made before the harrow is required for use again. The rusty harrow tooth will ball up, collecting grass roots and soil particles in moist ground, reducing the efficiency of the work. It pays well to keep the harrow teeth bright and sharp.

The place in the implement shed for harrows where such will be out of the way is up on the side walls. Long pegs or spikes that will hold two sections can be driven in the studs or wall boarding and the harrow sections hung thereon high, dry and easy to get when wanted.

In selecting a harrow it is well to keep in mind the type of soil that it is desired to use it on. Heavy and stony soils require a heavy harrow, while on the other hand the lighter types of harrows are to be prefered for light soils. Harrows equipped with the large head type of spike or tooth do not give trouble through lost parts as is common with other types. The lever harrow which permits of quick adjustment for various classes of work is replacing the old type rigid frame harrow.

The Disc Harrow.

This tillage machine is made in various designs—the full disc, the cutaway disc, the spading disc. All three have their special uses in soil tillage and require the same attention to keep them in the best working condition. The full disc is to be prefered for all work excepting meadow renovation and use on damp or wet soils. It has been difficult for implement manufacturers to make a disc harrow bearing that is dust and sand proof. The bearing and its neglect on the part of the operator is the cause of nearly all disc harrow trouble. Neglect to oil has serious results. A sixteen inch disc will turn 660 times in an hour at ordinary horse speed, with considerable pressure from two directions on its bearings, hence the need for frequent lubrication. A bearing of good size in which the journal box is fitted with the renewable type of wood journal and also fitted with a large size hard oil cup will give the best service providing its design is such as to prevent sand or other grit from getting in. If the bearings become worn the draft is greatly increased, so careful oiling right from the first day is essential if full service is to be obtained at minimum expenditure of labour. The rusty disc will give considerable trouble and may cause long delays in the early spring. Rust may be prevented by putting the disc away in the autumn in a clean, dry condition. A little rub with an oil soaked cloth will help keep the wearing parts bright and always ready for the field. The cutting edge of the discs will wear round through use on a stony or hard clay land unless ways and means are taken to retain the cutting edge. Disc grinders that are specially designed for sharpening discs can be purchased and should be at hand in the farm work shop for use on wet days or at other times when work in the fields cannot be carried on. A wrench to keep bolts tight and a supply of lubricant for the bearings should always accompany the disc harrow to the field.

The Seed Drill.

The seed drill shows the result of neglect in a way so impressive as to deter the owner or operator from abusing this machine to the same extent as he may practise with the plow or harrow. A warped seed box, rusty and clogged grain runs leave tell tale evidence over the field that even makes the neglectful man repent. With many moving parts, the drill requires frequent careful oiling. Disc and double disc drills having many more moving parts than the shoe or hoe type of drill, and with the disc bearings subjected to dust and sand, will develop considerable trouble if there is any neglect to keep the bearings properly adjusted and oiled. When once the bearings become worn, it is impossible for the disc to function properly and renewal of the parts that have become worn is the only remedy if the drill is to give best service. All bearings should

receive attention and be kept clean and free from grit. This is best done by a frequent application of light mineral oil. The grain drill bearings are not the easiest to get at; a long flexible stem oil can, is generally the most useful type of oiler. An oil can should be carried with the seed drill at all times. The large wheels turning slowly may not need oiling more than once each half day, but the discs may turn 15,000 times in a day under considerable pressure, hence the need of frequent oiling for the disc bearings. The seed box mechanism turning slowly can generally be well served by oiling twice a day. The grain drill should not be exposed to the weather when not in use; a canvas cover sufficiently large to fully protect the grain box should go with this machine for use over night or idle periods if it is not desired to move the drill back to its proper storage in the implement shed until the close of the seeding season. The matter of keeping bolts tight and everything in adjustment is just as important with this machine as with any other. If the drill gets proper care, it will last the lifetime of the operator.

The Manure Spreader.

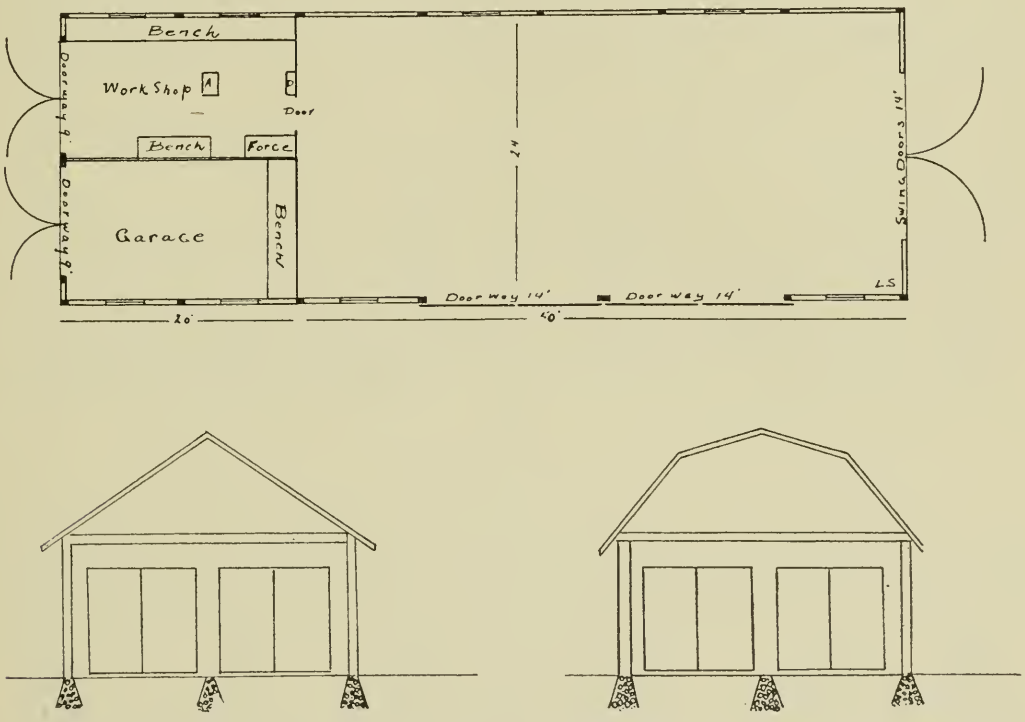
The manure spreader is generally much neglected, due to the character of the work that the machine performs. When men neglect to oil machines that are free from filth their inclination to take care of the manure spreader is almost negative. The use of hard oil or grease cups on all bearings possible is advised. Once filling will take care of the requirement for a week if the machine is receiving intelligent care. On those bearings where grease cups are not practical, provision should be made for easy accessibility and also protection from foreign matter. The work performed by the mechanisms that drive the beater and also move the heavily laden conveyer is much greater than the average farm man appreciated, hence the neglect to apply ample lubrication. Worn and broken drive chains, sprocket wheels and worm gears with the costly delays consequent on their replacement is generally the result of neglect to lubricate. An oil can kept well filled can do much to aid in getting the full efficiency out of your investment. At the end of the period of use the spreader should be cleaned by using a broom and a stream of water from a hose. When clean the machine should be exposed to the sun long enough to dry, oiling of all bearings and rollers should follow. The metal parts should be brushed over with a light mineral oil or grease and the spreader then stored in a dry shed.

Lubricants for Farm Machines and Implements.

Heavy oils and greases are used on all bearings where the pressure is great and the movement slow, as on axles, and shafts. Generally speaking the greater the speed of the turning part the lighter the lubricant used. No oil should be used that has not sufficient body to remain on the surface of the shaft and bearing for a reasonable length of time. All farm machines excepting engines and cream separators can be kept well lubricated with the heavier oils and greases. Cream separators running at high speed require a light high grade oil, while gasoline engines require an oil of medium body and capable of standing a high temperature. Grease or hard oil cups should be attached to all bearings where practicable. It is advisable to purchase high grade oils and greases in bulk and keep on hand at all times a sufficient quanity to take care of the needs of the machinery. An oil can holder should be tacked to every farm implement and every implement should have its special oil can.

The Implement Shed.

Shelter will prevent waste. Weathering elements soon destroy the wood or metal used in implements, perhaps not fast enough to excite the owner into action, but nevertheless slow, sure and steadily the wood will decay, and the metal will rust, until the implement becomes too weak to stand the strain of use. Neglect to provide shelter for implements is generally more noticeable in the newly settled parts of the province. Such should not be the case considering the abundant material at hand suitable for sheds. A humble structure made of



An Implement Shed suitable for a 150-acre farm—either type of roof may be used—small cement posts for foundation or a six-inch wall if a cement floor is desired.

poles and bark will give good protection to the few implements required by the settler until such time as he can afford something better.

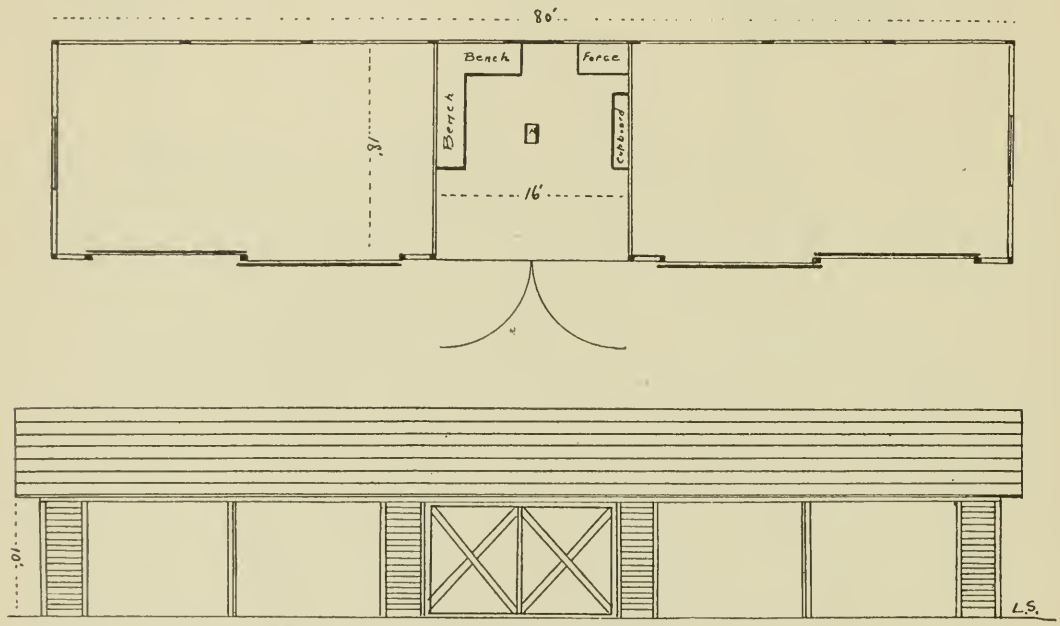
Design.—Implement sheds should be so designed that the accessibility of the implements stored therein will always be easy. Wide implement sheds are generally not as convenient as the narrower structures unless designed with doorways on both sides, or alleyways kept clear to facilitate the movement and storage of the implements. The storage of implements in the farm barn or any other expensive building is not economical, first because the implements need protection only from weather, which can be furnished by a comparatively cheap structure; secondly, time is saved in getting in or out when the implements are kept in a building devoted to implement storage only.

Location.—The implement shed should be so located that time will not be lost in travelling more steps than is absolutely necessary with or to get implements either going to or returning from work. Where horses are used as the main farm power, the implement shed should be located near the stables, at a point where the teams can conveniently pass on the way from stable to field. On many farms the implement shed can be located at a point between the house and barn, a very desirable location especially if the building is to be used for

the motor car and also the workshop. The approach should be sufficiently wide to permit the backing of wagons into or out of the shed.

Size.—For a one hundred acre grain and live stock farm fully equipped with the necessary machinery, a shed 60 feet long and 24 feet wide is generally amply large. Different types of farming call for different tools and implements, so before deciding on the size of building to erect, determine the floor space required for each tool or machine and plan a shelter large enough to cover all.

Foundation. The implement shed being a light structure does not require a heavy foundation. A light cement wall under the sills or small pillars under the posts is all that is required. Small pillars of cement can be made by filling a half barrel, a nail keg or special form with a one to six cement and gravel mixture. If the foundation used is to go below the surface, care should be taken

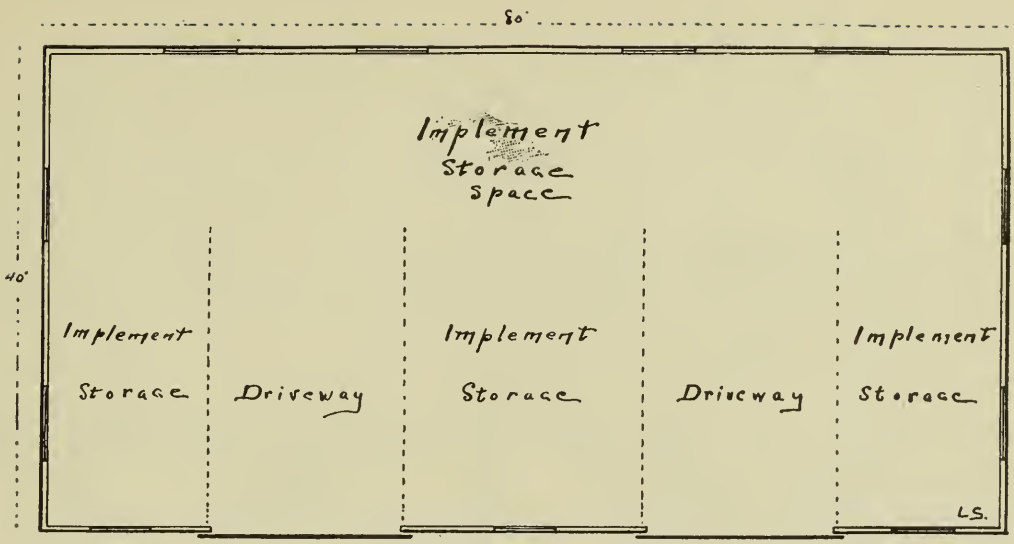


An Implement Shed with workshop in the center.

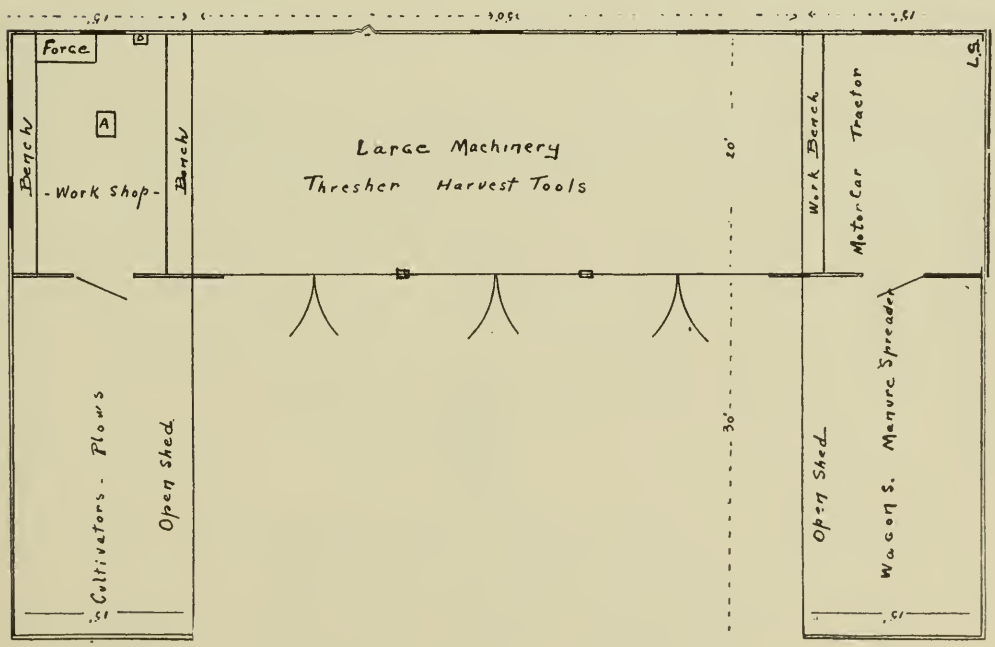
to have such below the frost line, Foundations set on the firm soil after the top vegetable mould has been removed are generally satisfactory in all parts of Ontario.

Floor.—A dry earth or gravel floor is all that is necessary if the shed is located on well drained ground. Cement is desirable where the cost of such is not excessive. Wood floors are the most comfortable to work on, but such are expensive and may provide harbour for vermin. Sand floors are objectionable. If an earth floor is decided on, the use of narrow boards under the wheels and runners of implements that are to stand any length of time is advised.

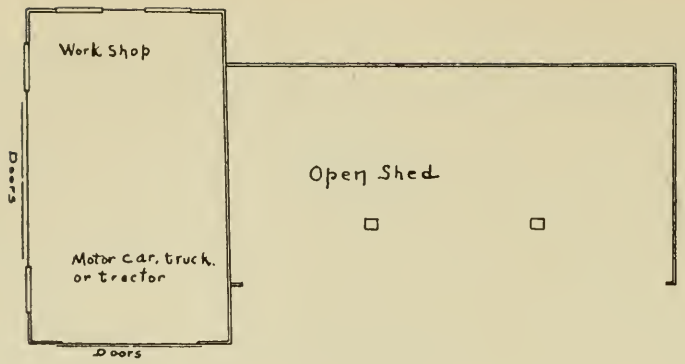
Walls.—The implement shed wall need only be heavy enough to support the roof and keep out the sun and rain and strong enough to give rigidity to the structure. Vertical boards and battens on a 2″ x 4″ frame will provide such at low cost. A covering of matched drop siding over a ship-lap sheathing will give a more durable and better appearing wall at a higher cost. Corrugated galvanized sheets or siding does very well and has the additional advantage of fire-proofing the structure. Cement block and brick walls, if on good foundations, are very desirable from the durability standpoint, but too expensive for the general farm. Walls made of poles and cedar bark will serve the purpose

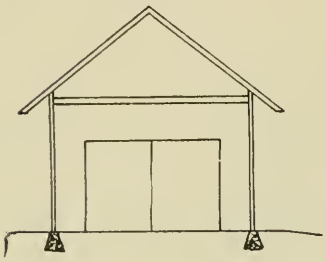


An Implement Shed for a very large farm—two driveways provide access to the tools, implements and machines. Driveways should be kept clear and not used as storage space during the tillage season.

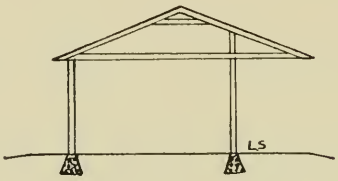


Implement Shed suitable for a large farm. Two wings are open-front structure for the wagons, manure spreader and tillage implements—a workshop, also motor car and tractor space, being located in the corners.



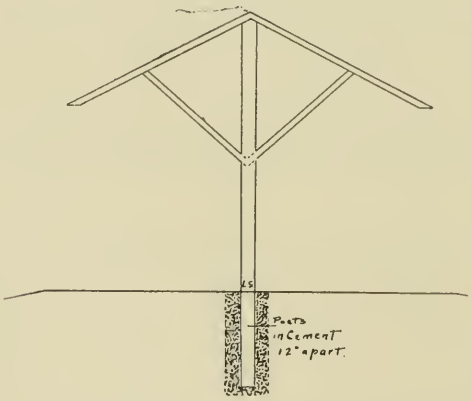


Cross section of closed part.



Cross section of open shed.

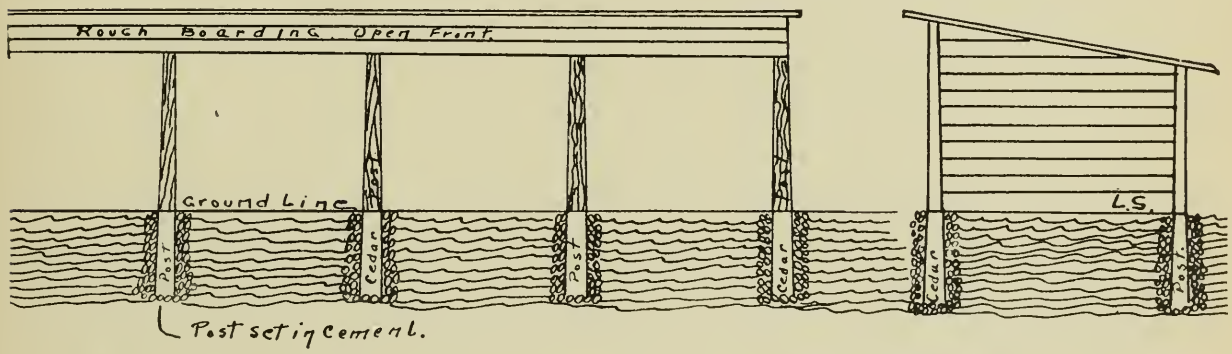
Implement Shed suitable for a small farm—a closed shed to accommodate motor car, truck, tractor, harvester machines and workshop. An open section for tillage machines and wagons.



Cross section of Sun Shade—a handy type of shelter under which wagons and farm tools and implements may be kept. Wide open during the work season so that teams can be driven out or in either side. Men are more likely to put implements under cover if there is no door to open and close. Doors can be used during the winter; if such are hung from above to swing up and in out of the way it will be most convenient.

of protection to the bush farmer's implements until he can afford lumber for building purposes. Log buildings, if made of peeled logs and set on stones, will last for many years if given a brushing over with creosote to keep out the beetles. Insects and the absence of waterproof foundations are the main causes of early decay in log buildings. Walls may be constructed of small, straight poles or logs pinned together with long spikes or firmly held by setting small, vertical posts in double line the width of the poles apart at intervals of eight feet.

Roof.—For narrow implement sheds the wide roof board and batten or galvanized sheets are the best coverings at low cost. Prepared paper coverings of tar or asphalt felts are very desirable, and have an advantage in that such are dust proof. Prepared papers are more expensive than the wide roof board



Front elevation. End elevation.

An Implement Shed constructed by using cedar posts set in cement, a pole plate and rafters completes the frame. Rough boarding for the wall covering and wide boards and batten for roof makes a cheap and efficient structure.

and batten. Shingles make a very acceptable covering for roofs of greater than one third pitch.

Frame.—The width and height of the structure will determine in a large measure the dimension of the structural material. Narrow buildings with gable or hip roof can be framed of 2″ x 4″ lumber. A building designed with shed roof will require heavier rafters; 2″ x 6″ for buildings over 12 feet wide, unless the building is high enough to permit the use of rafter braces. Corner posts, sills and plates may be one piece 2″ x 6″ or doubled 2″ x 4″. Sheds that are built open front must be well braced to stand both side and downward strain. In open front sheds it is generally desirable to set the posts on the open side well in. A convenient type of shed or shelter may be constructed by erecting one line of posts and constructing thereon a frame that will give sufficient width to shelter waggons or large implements and be wide open all round during the period when farm implements are in use. Provision for closing in such a shed can be made by providing doors or panels which may be put in place by the use of hooks or hinges. Such doors or panel to swing up and in. The posts for a shed of this type should be set in cement.

Ontario Department of Agriculture
ONTARIO AGRICULTURAL COLLEGE

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THE BROOD SOW

By R. G. Knox, B.S.A., Lecturer in Animal Husbandry,
and
Wade Toole, B.S.A., M.S., Professor of Animal Husbandry.

INTRODUCTION

Selection, Feeds, Management, Costs and Housing.

It is doubtful if at any time in the history of the swine industry in Canada, more co-operative and concentrated effort was required than at the present time to sustain that industry. The effect of our competitors in offering bacon products in larger quantities and of more uniform quality, is being keenly realized by our hog producers. While the spread in present-day prices paid for

Young sows in pea and oat pasture in the College paddocks.

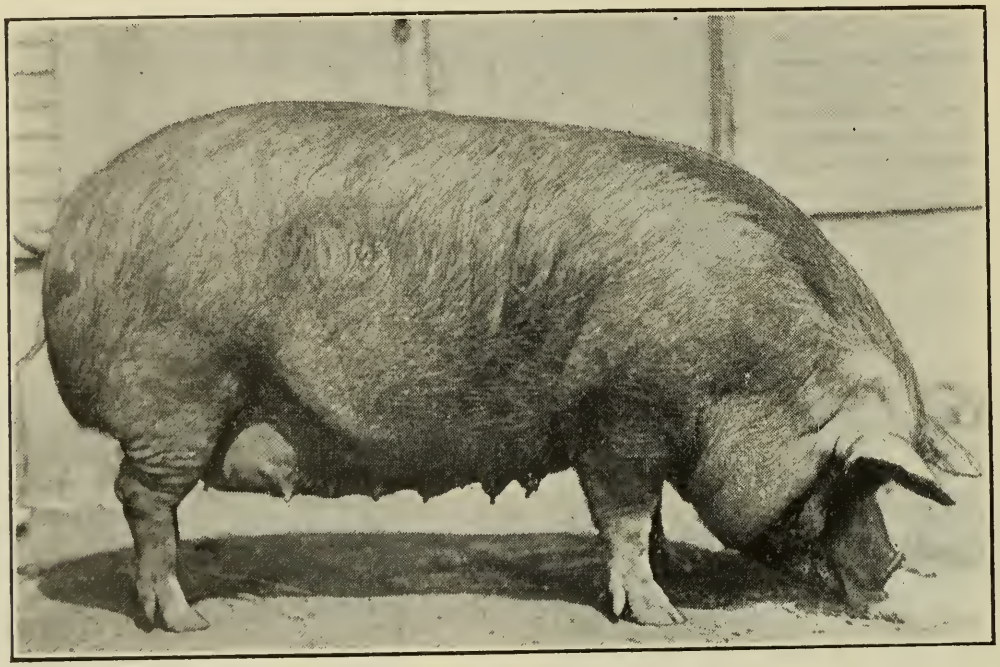
A shade is necessary in summer. Pigs at Ontario Agricultural College.

Danish, Irish and Canadian bacon would indicate a decided discrimination in favour of the first-mentioned countries, British buyers are ready to acknowledge that there is a considerable quantity of the Canadian product which compares very favourably with that of our competitors. The trouble lies in the fact that there is not enough of the good quality bacon available at all seasons of the year to create a strong, permanent market. To attempt to produce high quality bacon without first having good quality bacon breeding stock is like attempting to build a house without a foundation. The art of properly rearing and feeding bacon hogs can only be demonstrated in its greatest efficiency when the feeder has the right type of hog to start with. There is no national economy in feeding hogs of a conformation which, when dressed, will not make Wiltshire sides in

demand on the overseas market. Our breeding stock, of whatever breed they may be, must be of approved bacon type and of high quality before we can expect to produce commercial hogs of anything like uniform type and quality.

The salvation of the industry, so far as the producers are concerned, rests with the men who have courage of conviction, who, despite temporary adversity are prepared to stay on the job from year to year and maintain a comparatively constant number of breeding sows of real bacon conformation, thus ensuring a more or less constant supply of commercial hogs. The in-and-outer never gets anywhere with anything in the hog business; he is a menace to his community, because of the unstabilizing effect on supply, he endangers the success of his neighbour. The conscientious and persistent producer of hogs is just as essential an asset for the success of the swine industry as the conscientious and persistent business man is for the success of any other business.

The brood sow has a place all her own on the farm. She is a felly in the live-stock wheel which no other class of live-stock can very well replace. The



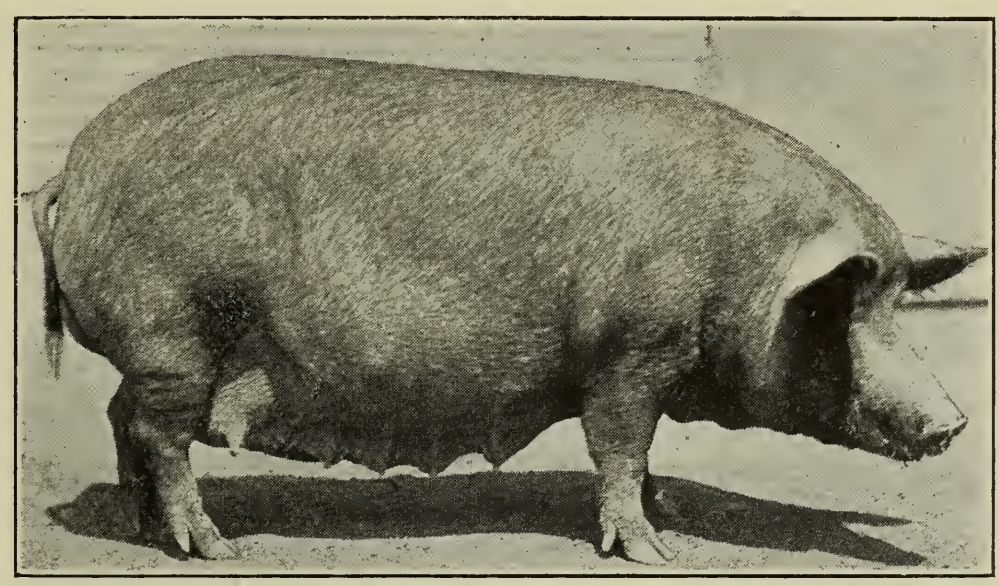
A Berkshire Sow at the O.A.C.
Note the length, strength and quality.

brood sow is a means of providing quick returns and large dividends, and has been rightfully called the "mortgage lifter." The natural increase is early and manifold. She provides a medium in herself and her offspring by which coarse and non-marketable grains may be marketed at an enhanced value, dairy by-products may be utilized to the greatest advantage, kitchen and garden wastes are turned into cash, and withal the fertility of the soil maintained to a greater extent than it would be were the grain and other feed sold off the farm. Keeping hogs on the farm also makes for better balanced and more progressive agriculture.

The Selection of a Brood Sow. The importance of the careful selection of a brood sow cannot be over-emphasized. It is true that the sow's influence is reflected on her own litters only, whereas that of the boar is reflected on all litters which he sires, and while many characteristics are common to both sexes of breeding stock, there are others which are very essential to the respective sexes and opposite in nature.

Information as to the history of the ancestry of a young sow is of considerable value. Experience and observation go to prove that certain outstanding qualities are common to strains or families of hogs of different breeds rather than simply breeds themselves. There are good and bad in all our breeds, consequently the prospective purchaser should ascertain as much information as he can concerning the type, the quality and the prolificacy of her ancestry, whether or not they have been thrifty and economic feeders and whether or not the sows have been good mothers. Canadian hog raisers can well take an object lesson from the results which the Danish breeders are experiencing where all the above information is available to the prospective purchaser. Moreover, every breeding hog must measure up to a certain standard before that hog is eligible for sale.

In 1921, the Department of Animal Husbandry of the Ontario Agricultural College supervised the problem of investigating 800 litters of each of seven different breeds, viz: Yorkshire, Tamworth, Berkshire, Hampshire, Chester White, Duroc Jersey and Poland China. This investigation covered this number



Tamworth Brood Sow.

She has been a consistent producer in the O.A.C. herd. Long, deep, and smooth, she is the kind that pays.

of litters farrowed in one year. The 5,600 litters farrowed numbered 49,400 pigs or an average per litter of 8.82 for a twelve months' period. This average is higher than most people would believe, and serves to place pure-bred swine in a better light than many see them. But when 5,600 litters of pigs from pure-bred sows and pure-bred boars of seven different breeds average all told, 8.82 pigs per litter, the pure-bred pig, so far as fecundity is concerned, stands above criticism; and while some breeds are more productive than others it will be noticed from a summary of results that each and every breed has a creditable record.

The data from which the results were obtained was secured from the Canadian Live Stock Records, Ottawa. When a breeder makes application to register the progeny of pure-bred sire and dam he must furnish:

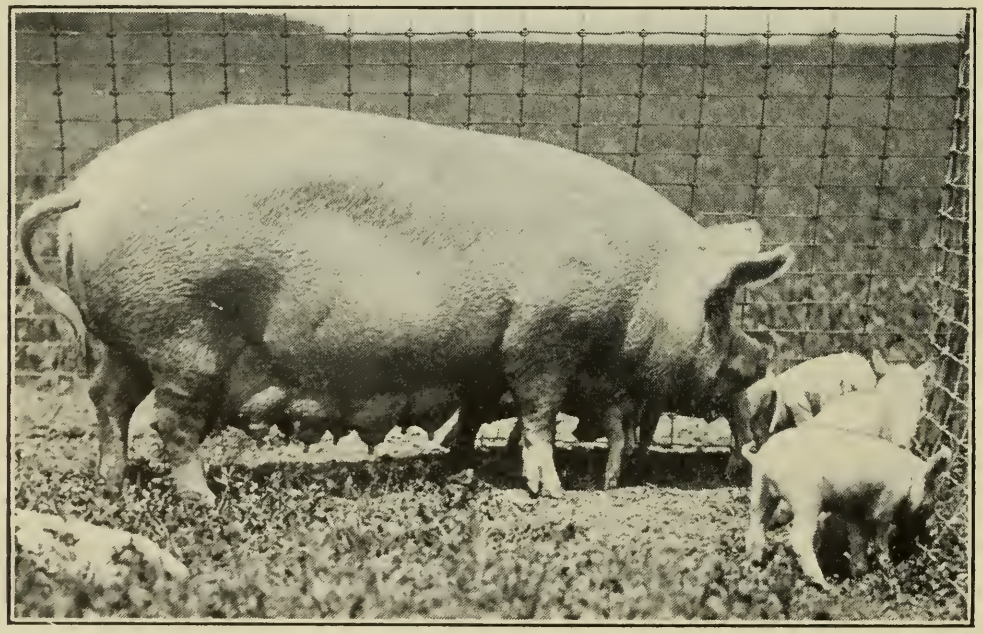
1. The number of pigs in the litter.
2. The number of males in the litter.
3. The number of females in the litter.
4. The date of farrowing.

These application forms furnished the source of the information which is reliable. The following table shows the average number of pigs per litter.

Breed	No. of litters	Average per litter
Yorkshire	800	10.2
Tamworth	800	9.4
Berkshire	800	8.3
Hampshire	800	8.2
Chester White	800	9.3
Duroc Jersey	800	8.4
Poland China	800	8.0

This table is of interest for several reasons. Besides proving that each and every breed is fairly prolific, it shows that the bacon breeds are in the lead with the Yorkshire at the top. This is important in Canada where the bacon hog is most in demand. It is well to notice, too, that the Berkshire and Hampshire breeds, which are sometimes considered as in between the strictly speaking bacon type and the pronounced lard type are, when grouped together, lower in fecundity than the three lard breeds, viz: Chester Whites, Duroc Jerseys and Poland Chinas, while the Poland with an average of 8 pigs per litter stands at the bottom. So far as size of litter is concerned they line up:

1. Yorkshire 10.2
2. Tamworth 9.4
3. Chester White 9.3
4. Duroc Jersey 8.4
5. Berkshire 8.3
6. Hampshire 8.2
7. Poland China 8.0



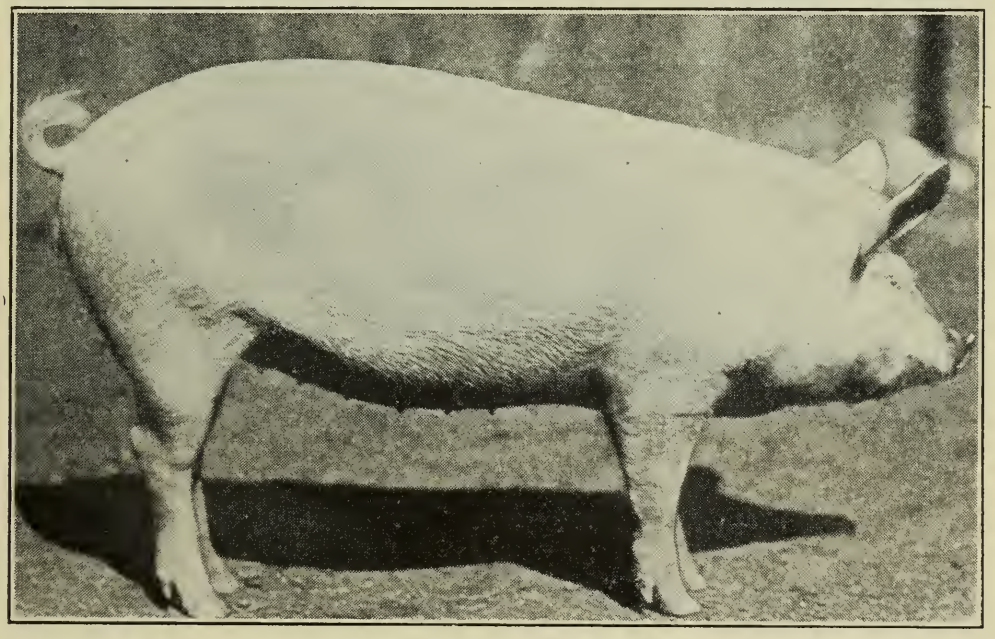
An old Yorkshire sow with eight pigs in a clover paddock at the O.A.C.

Some think that the Canadian climate is too severe for best results in swine. This may be so, but the results of investigational work covering 85,000 litters in the States, showed a litter average of 8.17. While not so many litters were studied in Canada, our average of 8.82 pigs per litter looks favourable to this country.

Other interesting information was revealed in the work. The percentages of males and females in the 49,400 pigs studied ran 48 per cent. males and 52 per cent. females, showing that the balance of the sexes is fairly well controlled in nature.

As to the individuality of the breeding sow, she should be typical of whatever recognized bacon breed she is a representative; she should be well-developed for her age; she should have an abundance of smoothness and quality throughout—quality of body, bone, skin and hair; she should be feminine in appearance and expression; she should have clean, strong bone so that she stands well on her feet; she should have sufficient strength and depth of body to indicate a strong constitution. One cannot expect a sow with a weak constitution to do justice to her young while rearing them. If the breeding sow happens to develop too much depth of body that the owner fears her offspring will have too much depth of middle to satisfy the market demands, it is a much wiser policy to mate her with a more shallow boar than to discard her. The brood sow with the long, deep, smooth, flat side is the kind to be depended upon. Last but not least, the breeding sow should have a sufficient number of teats to nurse her young, and they should be evenly placed and well forward. A sow with ten teats farrowing thirteen or fourteen pigs spells mortality and reduction of dividends to the owner.

When a really good sow is once obtained, she should be kept in the herd as long as she retains her usefulness. A really first-class sow is not too easily obtained, and so long as she continues to produce satisfactory litters, she should not be disposed of.



An Eight-Months-Old Sow.
A good type to select (in O.A.C. herd).

MANAGEMENT OF THE YOUNG GILT.

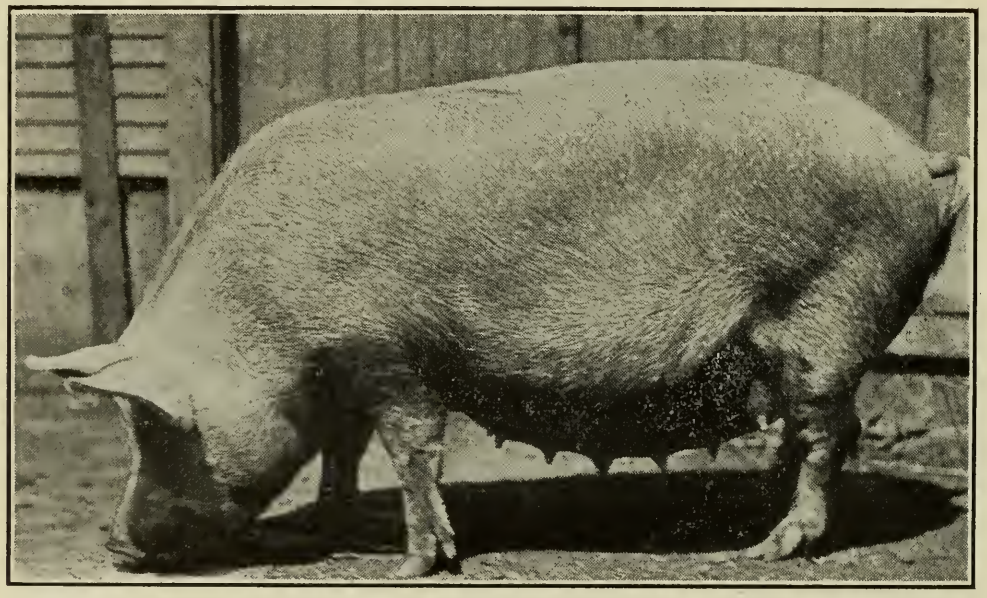
Care and Feeding during Development. The young gilt selected for breeding purposes should not be forced along as if she were going to be marketed for pork, but rather the system of growing her as followed during the early stages of her life should be followed. A healthy, thrifty gilt in moderate flesh should be the objective, so that instead of being soft and flabby when she is called upon to carry her first litter, she is strong, firmly fleshed and in a condition to nourish and develop the foetus she is carrying with no undue forfeiture to herself.

During the summer months possibly there is no more economic and satisfactory method to develop the young gilt than to turn her out on good clover

pastures. An annual pasture such as peas and oats, sown at the rate of 2¼ bushels of oats and half a bushel of small peas or 1 bushel large peas to the acre, together with a mixture of clovers (red 8, alsike 3, sweet clover 4) at the rate of about 15 pounds to the acre, gives very good satisfaction. Pigs are turned into this crop when it is about 8 to 10 inches high. Rape is also a suitable pasture crop on which to develop young gilts being kept for breeding purposes. Shade of some description should always be of easy access.

While on pasture, the young gilt does not require very much grain. A six to seven months' old gilt will not require more than 3 to 4 pounds of mixed grain per day along with about 10 to 15 pounds of whey with water *ad lib.* to keep her in good growing condition; the amount of grain, of course, to be governed by the age, size and condition of the gilt and whether or not whey is available.

Age of Breeding. A gilt which is well-developed should be bred when between eight and nine months of age unless she is intended for exhibition purposes, when it is advisable to give her a couple of months more to grow. A



Yorkshire Brood Sow.
This O.A.C. sow is carrying her second litter.

gilt should not be bred too young because the young sow will not usually have the strength to properly nurse her litter without sapping her own vitality to such an extent as to hamper her own development. If she is unfortunate enough to lose some of her first litter through lack of nourishment, her mammary glands will not develop properly, and as a consequence, subsequent litters will suffer, all of which tends to deplete her future usefulness.

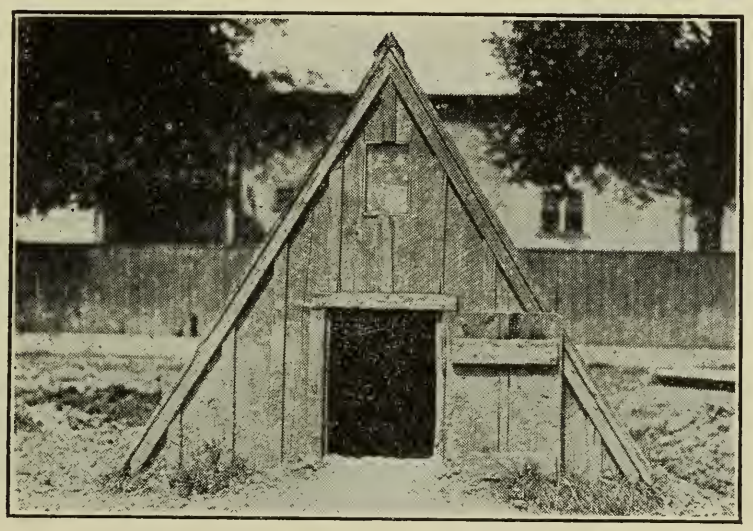
It is not advisable, however, to allow a well-developed gilt to run too long before being bred, since there appears to be a tendency toward the development of coarseness when a gilt runs barren too long.

Care During Pregnancy. As the young sow commences to show signs of pregnancy, she should not be called upon to rely altogether on the pasture for her maintenance. Not that she should be taken off it, but she should be getting a sufficient amount of grain to maintain her own body as well as develop the foetus. The value of pasture to the pregnant sow is not only because of its succulent nature and nutritious variety, but because there is in it a considerable amount of mineral matter available which is essential to the development of the young.

If, on the other hand, a young sow is being carried through the winter months, the aim should be to provide her with as near summer conditions as possible, with respect to exercise, succulent feed in the form of roots, access to a mineral mixture and a grain ration of equal parts barley and oats fed with skim milk or buttermilk, if it can be spared or in lieu of skim milk feed about 10 per cent. tankage. The care given a young sow previous to her farrowing her first litter is a strong determining factor in her development and future usefulness.

FEEDING AND MANAGEMENT OF THE DRY SOW

Summer Management. During the summer months, the dry brood sow requires very little special care if she is provided with reasonably good clover or annual pasture and shade and water. As soon as milk secretion has ceased the aim of the owner should be to feed her so as to have her gaining in condition when she is bred. It is neither wise nor profitable to breed a sow the first time



The "A" shaped house is good summer shelter in the paddock.

she shows oestrum after weaning if she is thin and run down. The sow that is gaining in flesh when bred is more liable to farrow a larger and stronger litter than the one which is thin and low in vitality. For the first part of the gestation period, about one-half pound of mixed grain per hundred pounds live weight, will maintain a dry brood sow while on pasture after she has recovered from the strain of nursing her litter. Often-times more grain than this is necessary to build her up during the first few weeks after milk secretion has ceased. Where whey is available, it can be economically fed up to about 15 pounds per day, when the grain ration could be slightly decreased.

If there are no shade trees in the field where the dry sows are running, the portable A-shaped hut or portable pen can be used to very good advantage.

The vigor, vitality and weight of newly born pigs are determined to a considerable extent by the care, ration fed and the exercise the sow has been allowed to take during the pregnancy period.

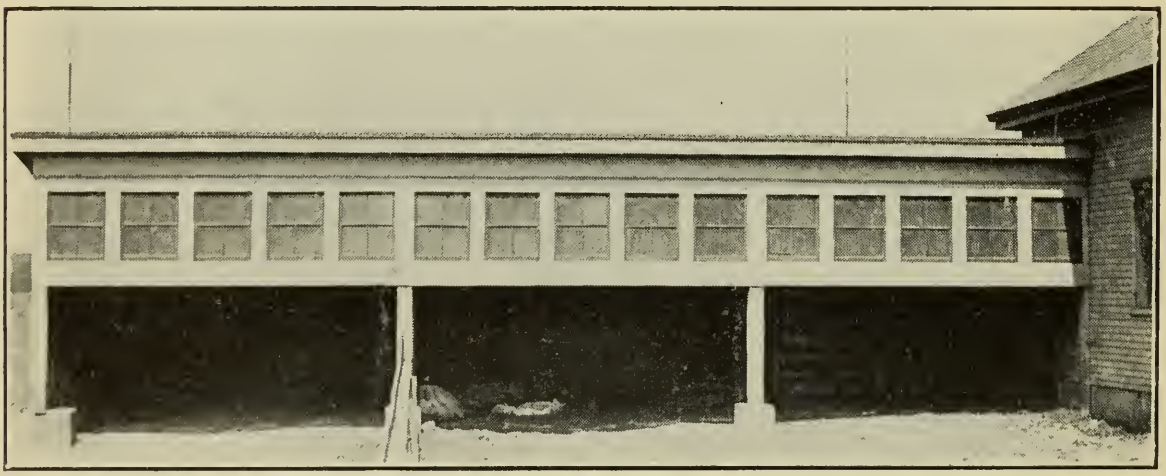
During the summer months when the sow is on pasture the question of exercise is automatically solved as is also the problem of variety and bulk of feed to a considerable extent. As pregnancy advances the sow should be receiv-

ing enough feed to not only maintain her own body, but also to develop the foetus so that when the farrowing period approaches there are no drastic changes in the sow's ration.

Winter Management. The winter quarters for dry brood sows need not necessarily be warm. All they require is a dry, storm-and-wind-protected place to live in. It is preferable to have it opening to the south. Dry brood sows do not appear to suffer from the cold so long as they have quarters well bedded with straw and are at liberty to roam about the barnyard for exercise. At the Ontario Agricultural College the dry brood sows are wintered in an open shed facing south with the front closed in to within four feet from the ground. The shed is sixteen feet deep, ten feet high in front, six feet high at the back and thirty-eight feet long, and comfortably accommodates 20 mature sows. They are given the freedom of a yard and so long as they have plenty of bedding are quite comfortable. The litters come strong and healthy, and the sows are in satisfactory breeding condition.

In the event of no shed being available, an A-shaped hut or portable pen can be used to very good advantage. As with the open shed they should be well-bedded and located where there is no danger of the floor becoming damp.

A brood sow must be allowed to take exercise; if she does not take it of her



Open shed at O.A.C.—where twenty brood sows winter in the open.

own accord, some method of inducing her to do so should be practised. Exercise promotes good health in the pregnant sow and ensures strong litters where the sow has been properly fed.

Brood sows in winter should get a variety of feed, including some succulent feed which can be readily found in mangels or sugar beets. The mature brood sow will relish a small amount of roughage such as alfalfa or red clover hay, or clean corn silage. The amount of her grain ration must be determined by her condition and size. Barley and oats, equal parts, makes a very suitable mixture to feed. Corn may be fed in a small proportion during the winter months when the sow is running outside. Owing to its heating nature, and lowness in muscle and bone-building constituents, corn should be fed sparingly during the latter part of the gestation period. If dairy by-products, such as skim milk or buttermilk are available, they can be fed economically during the winter months. A brood sow should always have access to some mineral mixture while she is in winter quarters.

During the winters of 1921-22 and 1922-23, experiments were conducted at the Ontario Agricultural College to determine the cost of maintenance of

brood sows. For the experiment, 9 brood sows divided into three lots, were used each year, and were fed for 71 days in 1921-22 and 66 days in 1922-23. In each case one lot was put on a ration of concentrates, skim milk and roots and the other two lots were fed a smaller ration along with mangels and either alfalfa hay or corn silage.

The following is a synopsis of the experiment of 1922-23 which, in results, duplicates that of 1921-22 quite closely:

	Average weight of sows	Average daily ration per sow	Average daily cost
			cents
Lot No. 1	425 lbs.	Mangels..... 7.43 lbs. Mixed chop... 5.72 " Whey.....18.77 "	10.8
Lot No. 2	509 "	Ensilage..... 2.54 " Mangels..... 6.30 " Mixed chop... 3.80 " Whey.....19.93 "	8.5
Lot No. 3	527 "	Alfalfa hay... 1.72 " Mangels..... 7.46 " Mixed chop... 4.24 " Whey.....19.93 "	9.3

Owing to the fact that with the exception of one in lot 3, the sows were all pregnant, gains in weight were not an accurate indication and the powers of observation had to be relied upon. In the case of the one sow not pregnant, the ration given lot 3 proved to be a little better than a maintenance ration, since she showed a slight gain in weight. However, while lot 2 showed a cost of .8 cents less per day, indications were that lot 3 were in by far the best breeding condition. Lot 1 were on the fleshy side for best results, although all eight sows farrowed good, strong, vigorous litters.

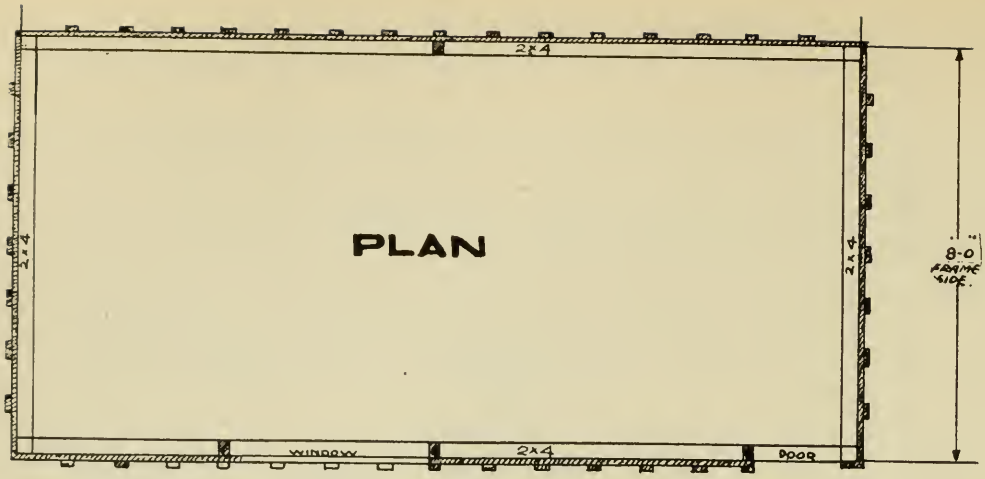
Market values of feeds used were as follows:

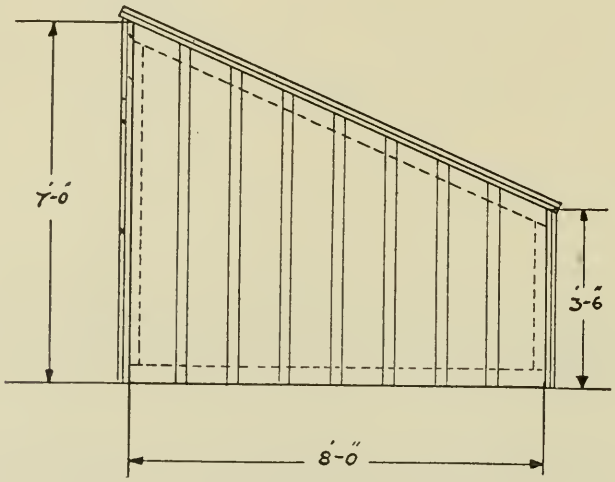
Alfalfa hay	$12.00 per ton	Mangels	$ .15 per bus.
Mixed chop	27.00 "	Whey	.05 per cwt.
Ensilage	5.00 "		

Period of Gestation. The period of gestation in sows is usually placed at 112 days. Occasionally a young sow will farrow a few days earlier than the stated time, and old sows go a few days over it. If a sow has been properly handled, she will seldom go more than a few days over sixteen weeks.

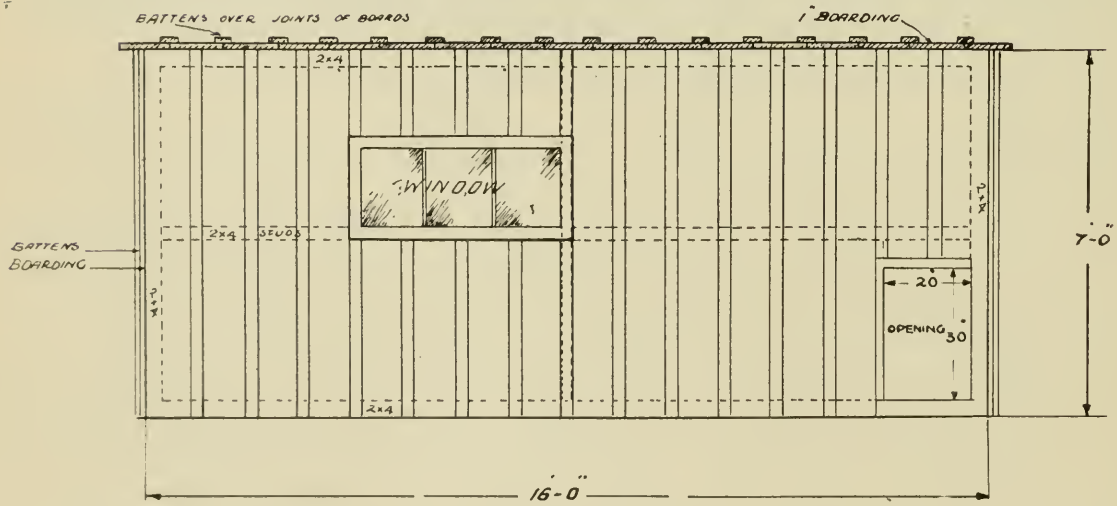
Best Time for Farrowing. Where winters are severe it requires considerable skill to raise winter litters successfully. Pigs farrowing during late winter and early spring are able to get outdoor exercise at an early date of their life, which is a great aid in keeping them healthy and thrifty. Then again pigs farrowed in early autumn have the same opportunity before the weather becomes wet and cold, and have a good start under somewhat natural conditions before going into winter quarters.

There is no good reason why a sow should not produce two litters a year, unless the owner is breeding for show purposes and wishes to leave his pigs with the sow as long as possible, as well as get his sows in high condition, when he will be able to breed his sows only once a year.





End View.

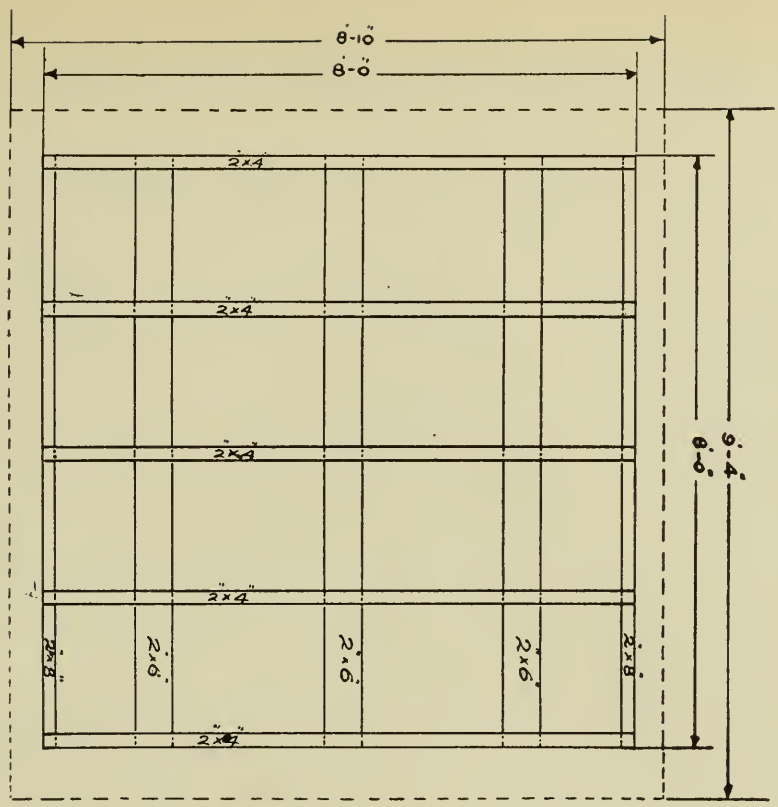


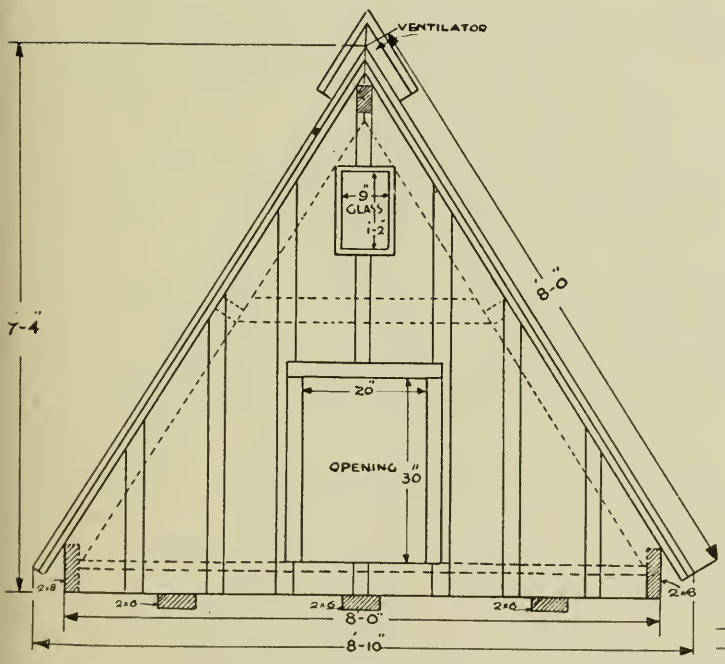
Side View.

PORTABLE PEN

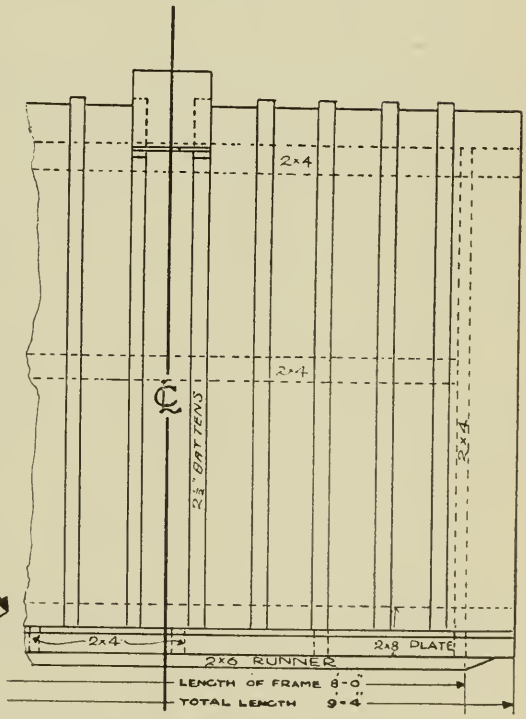
Bill of material for the construction of pen.

1 length scantling, 2″ x 4″ x 15′ 4″ long; 4 lengths scantling, 2″ x 4″ x 16′ long; 3 lengths scantling, 2″ x 4″ x 6′ 8″ long; 2 lengths scantling, 2″ x 4″ x 3′ 2″ long; 3 lengths scantling, 2″ x 4″ x 12′ long; 1 length scantling, 2″ x 4″ x 4′ long; 244 sq. ft. of 1″ rough boarding; 2½″ x 1″ battens, 400 lineal feet; 1 window frame, outside measurement, 4′ 3″ x 2′; nails, glass, etc.





End Elevation.



Side Elevation.

THE "A" SHAPED PEN

Bill of material for the construction.

3 lengths of runners, 2″ x 6″ x 9′ 4″; 2 lengths of side boards, 2″ x 8″ x 9′ 4″; 5 lengths of scantling, 2″ x 4″ x 7′ 8″; 1 length of ridge support, 2″ x 4″ x 9′ 4″; 4 lengths of scantling, 2″ x 4″ x 7′ 6″; 2 lengths of scantling, 2″ x 4″ x 8′; 216 sq. ft. of 1″ boarding; 2 lengths, 1″ x 3″ x 2′ 6″; 2 lengths, 1″ x 3″ x 2′ 2″; 160 lineal feet of 1″ x 2½″ battens; nails, 4″ and 2½″.

MANAGEMENT AT FARROWING TIME.

Preparing the Farrowing Pen. There is an old and wise saying to the effect that "A stitch in time saves nine." No where is this truer than in making foresighted preparation for the young pigs. The farrowing pen, if in the main piggery, should be closed off from the remainder of the building. Young pigs do not thrive well when they are allowed to breathe the same air as feeder and older pigs. Where the farrowing pen is completely closed off, it is much easier to keep the air purer and drier. Then again there is less danger of a sow becoming excited or nervous because of the noise of other pigs. The farrowing pen should be from 8 to 9 feet wide by 11 to 12 feet deep, and the ceiling around 8 feet high.

Good results may be experienced from having sows farrow in a portable, single pen (see cut) even in cold weather. When using it for this purpose, it is necessary to line the inside of the pen with building paper and then on top of this, an additional lining of closely fitting lumber. A small ventilator through the roof at one end completes the equipment. Care should be taken that the pen is free of drafts and that the location is dry.

The farrowing pen must be dry, well-ventilated and have a reasonable amount of light. A damp, cold floor can be made dry with a false floor which should be large enough to cover the space used as a sleeping place for the sow—9 feet by 7 feet is large enough for a mature sow.

The farrowing pen should have a guard rail along the wall surrounding the sleeping bed to prevent the sow crushing her young. It can easily be constructed by fastening gas pipe or 2 by 4 scantling about 8 to 10 inches from the floor and 10 to 12 inches from the wall.

The farrowing pen should be ready a week in advance so that the sow will have had an opportunity to become familiar with her new quarters before farrowing. Previous to turning her in, the pen should be thoroughly cleaned, repaired and disinfected with some standard disinfectant.

It is a good practice to bed lightly with either cut straw or fine chaff at farrowing time, and for about a week afterward. The fresh-farrowed sow, especially if in high condition, if given a lot of coarse bedding very often makes a deep nest which is a death trap for the young pigs.

Plan the work so that close personal attention can be given to the sows and litters during the farrowing season. Possibly the greatest mortality of pigs occurs between farrowing and weaning time. The personal factor at this particular time is a very strong one. Many a pig has been lost by crushing, because of the sow's lack of confidence in the attendant. Kindness pays. The powers of observation are very much brought into play during this time. Watch the appearance of the sow, the condition of the bowels, the condition of the udder and the appearance of the young pigs. Do not expose the young pigs to cold drafts or rain.

A farrowing sow should not be disturbed if everything is going well. Good mothers do not usually get up while farrowing or immediately afterward. As a rule, the newly-born pig will find its way to the teat and nurse soon after birth, although often-times many may be saved by giving them a little assistance at this time.

In case the new-born pigs become badly chilled they may be warmed up by putting them in a tub or basket in the centre of which a large jug of hot water is placed. The heat can be retained by covering the tub over with a piece of canvas or sacking. Hot bricks may be used instead of the hot water jug.

Occasionally a sow will be found which will eat her young. It is claimed by some, that this tendency is caused by allowing them to eat their afterbirth. As a precautionary measure the afterbirth should be promptly removed from the pen. There is little doubt that the trouble is caused in most cases by a fevered condition of the sow, which is often induced by injudicious feeding before farrowing. Unless she is a very valuable sow, and she persists in this practice, the best policy is to fatten her for the butcher.

Feeding Before and After Farrowing. It is a common mistake to overfeed the sow just before and after farrowing. As pregnancy advances the careful feeder should be gradually increasing the sow's feed to maintain her condition while the foetus is drawing quite heavily from her own body.

Corn should not make up much of the sow's ration at this time because corn does not contain enough muscle and bone-forming constituents to properly develop the unborn pigs, and is heating in nature as well. The feed that has a heating effect should be avoided at this time. Such feed tends to increase rather than reduce the feverish condition of the sow. The supply of succulent, laxative feed should be maintained in order to keep her digestive system in a healthy condition and her bowels loose. No drastic changes in the sow's ration should be made around farrowing time. A small amount of oil meal added to the ration is helpful to prevent constipation. Constipation is one of the main things to be guarded against at this time. If a sow becomes constipated before she farrows, she is very liable to lose her pigs. Moreover, her own life is endangered. When it once occurs very little can be done to overcome it, so that it is almost a matter of prevention. The best means of prevention are to make no radical changes in the ration, either grain or succulent feed, when she is put in the farrowing pen.

As soon as the sow shows signs of preparation to farrow, feed only a light cooling ration at regular feeding hours. After farrowing, she should not be disturbed even if she lies quietly for eight or ten hours. When she wants anything to eat she will go to the trough for it. At first, she should have little more than a drink. A very thin slop of middlings and skim milk will do very well. If the weather is very cold, all drink should be warmed for the first few days. During the first three or four days, great care should be taken to not overfeed, both as to quality and quantity. As soon as she has recovered from her sickness, a small ration of middlings and ground oats makes a very satisfactory feed. This ration should be gradually increased so that at the end of ten days she is practically on full feed. As the litter continues to grow and develop, it should be the aim of the feeder to give the sow enough feed to maintain her own body as well as nourish her young. Good mothers with large litters will usually lose some flesh in spite of most liberal feeding. By the third week of lactation, a small addition of barley should be made, gradually increasing until the sow is getting a grain ration of equal parts oats, barley and middlings. Skim milk or buttermilk can be very economically fed to a sow nursing young. They are rich in bone and muscle forming constituents. increase the palatability of feed, and add variety. In the event of skim milk or buttermilk not being available, tankage up to ten per cent. of the ration should be fed. Roots should also make a part of the ration when pasture or other green feed is not available. They are succulent, make bulk and promote good health. It must be borne in mind that at no time do pigs make as economical gains as when sucking their dams. Furthermore, it is essential to feed the sow well so that the young pigs may get a good start in life. Just as early as is possible after the litter becomes strong and active, the sow and her litter should be turned on good pasture. At first,

they should only be out for a short time, preferably during the cool part of the day. It is not wise to give the sow a very large range at first, as she is likely to travel too far and unduly tire the pigs.

Exercise is very important for young pigs, and every possible means of securing it must be adopted. If they are kept in a small pen there is the danger of possibly the best of them becoming too fat and dying from thumps or other diseases which soft, flabby pigs appear susceptible to. Outdoor exercise is especially beneficial, but pigs should be protected from cold winds or a very hot sun.

By the time the young pigs are three or four weeks old, they will have learned to eat. If at all possible, it is a good plan to give them access to another pen where they can have a small trough to themselves. Here they can be fed a thin slop of skim milk and middlings, and as they grow older, the proportion of middlings may be increased. During winter months, a small amount of soaked grain scattered on the floor will cause them to take exercise while hunting for it. Where it is impossible to provide an extra pen, the sow may be turned out while the young pigs are being fed. Pigs that have learned to eat well before being weaned do not suffer any serious setback when the sow is taken away from them.

If at any time during the lactation period, the sow's udder becomes hard and inflamed, it is a good plan to bathe thoroughly with hot water and apply equal parts of lard and turpentine.

Boar pigs, not intended for breeding purposes, should be castrated two weeks before weaning to get the best results. Clean hands, a clean sharp knife, and the use of a disinfectant upon the wound will obviate practically all danger.

While young pigs will thrive and do well if allowed on the sow only six weeks, they will do better if left for eight weeks, and the extra gain more than compensates for the increased cost of feed for the sow over the longer period. When the pigs are weaned the sow's feed should be cut down in quality and quantity for a few days in order to check the milk secretion. Occasionally it is necessary to feed dry feed with a small amount of drink given separately. If the udder gets very full it is a good plan to turn the sow in with the pigs once a day for a few days.

As soon as the milk secretion has ceased the sow is once more ready to be conditioned in preparation for breeding.

YEARLY MAINTENANCE OF BROOD SOWS

During the year ending June 1st, 1923, a complete record was kept of the feed consumed, the number of pigs farrowed, and the number reared by 16 mature brood sows owned by the Ontario Agricultural College. The sows were in just good breeding condition, and an attempt was made to maintain them under as near farm conditions as possible. No charges were made for labour, interest in investment, etc.

While market prices for feed fluctuate from year to year, the amounts of feed required are fairly constant and are of more importance since they are after all the basis for determination. The value of the knowledge of the cost of maintenance is brought out when making a comparison of sows as to their prolificacy and the number of pigs which they rear in a year.

The following table is a synopsis of the total feed consumed with the total cost for each sow and the number of pigs farrowed. It will be noted that there is no separate column for oats. They were added to the mixed grain total and charged at the price quoted in the table:

TABLE 1. SHOWING NUMBER OF PIGS FARROWED, THE AMOUNTS AND VALUE OF FEED CONSUMED.

Sow	No. of pigs farrowed.	Lbs. mixed grain and oats.	Value at $1.40 per cwt. Oats at 65c. per bus.	Lbs. middlings.	Value at $28.00 per ton.	Lbs. milk (skim)	Value at 30c. per cwt.	Lbs. whey.	Value at 5c. per cwt.	Lbs. mangels.	Value at 15c. per bus.	Mos. on pasture.	Value at $6.00 per acre rent.	Corn silage at $5.00 per ton.	Hay at $12.00 per ton.	Value.	Total.
			$ c.		$ c.		$ c.		$ c.		$ c.		$ c.		$ c.	$ c.	$ c.
No. 1	11	1541	21 57	368	5 15	2804	8 40	1196	59	610	1 80	4	40	100	....	25	38 16
No. 2	21	1540	22 39	324	4 53	2254	6 76	1680	84	757	2 25	5	50	....	....	...	37 27
No. 3	22	1267	17 73	244	3 41	358	1 07	2512	1 25	710	1 77	5	50	....	114	68	26 41
No. 4	19	1618	22 65	328	4 59	1498	4 49	2420	1 21	865	2 60	5½	55	168	....	42	36 51
No. 5	24	1570	21 98	395	5 53	1476	4 43	1760	88	1047	3 15	3	30	....	....	...	36 27
No. 6	22	1559	21 81	340	4 76	1740	5 22	2136	1 06	1000	3 00	4½	42	168	....	42	36 69
No. 7	23	1405	19 72	388	5 83	1144	3 43	1872	93	750	2 25	5	50	....	....	...	32 66
No. 8	5	1203	16 84	204	2 86	996	2 99	1764	88	600	1 80	6	60	100	....	25	26 22
No. 9	7	1181	16 53	117	1 63	692	2 07	2054	1 02	550	1 65	5½	55	100	....	25	23 70
No. 10	19	1399	19 59	328	4 59	2724	8 16	784	39	806	2 40	5¼	52	....	....	...	35 65
No. 11	10	1307	18 29	293	4 10	442	1 33	2490	1 24	910	2 70	6	60	168	....	42	28 68
No. 12	12	1341	18 77	287	4 01	445	1 33	2827	1 41	1108	3 30	4½	45	....	114	68	29 95
No. 13	16	1277	17 89	109	1 53	886	2 66	1568	78	945	2 80	5	50	....	....	...	26 16
No. 14	15	1282	17 94	145	2 03	1030	3 09	1578	78	945	2 80	5	50	....	....	...	27 14
No. 15	23	1512	21 16	367	5 13	928	2 78	2290	1 14	970	2 85	5	50	....	114	68	34 24
No. 16	12	1450	20 30	311	4 35	2163	6 49	1611	80	840	2 70	5½	55	....	....	...	35 19
Average.	16.3	1404		284		1348		1908.8		838							31 93

NOTE: Sow No. 3 had farrowed about ten days previous to the end of the recording year which accounts for the lower cost of maintenance.

In table I, it will be noted that there is quite a spread in the amounts of feed consumed, and likewise in the cost. It will also be noted that the sow farrowing the largest number of pigs does not always cost the most money to maintain.

The average amount of feed consumed for a year was 1,404 pounds of grain, 284 pounds middlings, 1,348 pounds skim-milk, 1,908.8 pounds whey, 838 pounds mangels plus pasture and roughage at a cost of $31.93.

TABLE No. 2. SHOWING YEARLY COST OF MAINTENANCE AND COST OF MORTALITY IN YOUNG PIGS.

	Yearly cost of maintenance	Average cost per pig when farrowed chargeable to maintenance of sow	Average cost per pig when 15-20 are reared per year to weaning age chargeable to maintenance of sow	Average cost per pig when 10-16 are reared per year to weaning age chargeable to maintenance of sow	Average cost per pig when less than 10 are reared per year chargeable to maintenance of sow
	$ c.	$ c.	$ c.	$ c.	$ c.
Sows farrowing 20 pigs or over	35 42	1 56	1 98	2 66	....
Sows farrowing 15-20 pigs	31 36	1 81	2 19	....	4 10
Sows farrowing 10-16 pigs	30 88	2 43	....	2 93	4 24
Sows farrowing less than 10 pigs	24 96	4 16	....	....	4 96

Average yearly cost of maintenance of sows rearing 16 pigs and over to weaning time...$ 36 10
" " " " " " 10-16 pigs to weaning time..... 31 62
" " " " " " less than 10 pigs to weaning time.... 28 53

Table No. 2 tells a more decided story. The amount charged against each pig at time of farrowing, in the third column, is based on the yearly cost of

maintenance of the sow regardless of how many pigs she raised to weaning age and serves the purpose of showing the value of a prolific brood sow.

The difference in charge per pig where 15 to 20 per year are reared between sows farrowing 20 pigs and over, and sows farrowing 15 to 20 pigs, is due to the fact that the former sows averaged nearer 20 pigs than did the latter, which goes to prove the further value of the sow which rear large litters.

The other three columns show the cost of mortality in young pigs between the time they are farrowed and are of weaning age. It is very obvious that every time a nursing sow loses a young pig she is diminishing the profits of her owner.

In spite of the fact that the sow rearing sixteen pigs or over per year costs more money to maintain her, she is a great deal more economical in the end. It costs approximately one dollar less per weaned pig to maintain a sow farrowing 20 pigs or over and rearing over 15 to 20 pigs per year than it does to maintain a sow farrowing and rearing 10 to 16 pigs per year.

It is also evident that while the more prolific sow may have hard luck she is a more economic producer than the sow farrowing small litters.

STANDARD RATIONS FOR BREEDING SOWS

NURSING:

For a 450 lb. sow:

Oats and barley, equal parts	7 lbs.
Middlings	3 lbs.
Skim milk	22 lbs.
Roots	7 lbs.

This is a ration when the pigs are young. Increase to 15 pounds of grain as the litter grows older. Corn or buckwheat might be used as one-quarter of the ration in place of barley. Whey, tankage, or oil cake could take the place of skim milk. In summer, green clover, alfalfa, peas and oats, or rape would largely take the place of skim-milk and roots.

DRY:

Equal parts barley and oats	1 lb.	per 100 lbs. live weight
Whey	4 lbs.	" " " "
Or skim milk	2 lbs.	" " " "
Or shorts or middlings 1/3 grain ration		
Roots	2 lbs.	" " " "

Cured alfalfa or red clover hay. All they will eat in winter. In summer 2 lbs. grain mixture per sow per day, when on pasture of clover, peas and oats, or rape.

MINERAL MIXTURE:

4 bushels charcoal or hardwood ashes.
8 pounds salt.
2 quarts air-slaked lime.
1 pound sulphur.
A small quantity of bone meal may be added to the above.

In feeding breeding sows the main factor to be kept in mind is that at all times they should be kept in as healthy and thrifty a condition as possible. Under-fed sows do not produce or rear strong, thrifty litters. Over-fed sows do not search for any feed and consequently do not take much-needed exercise.

In winter months, some palatable roughage in small quantities should be fed to give a little bulk to the ration. Where well cured alfalfa or red clover hay are available either answers the purpose very well. Roots are of special value to the brood sow in winter as is pasture in the summer.

Where skim milk is not available, tankage is a fair substitute for the nursing sow. Where green alfalfa or red clover or peas and oats or rape are available during the summer months, skim milk and other protein rich feeds are not so essential. Where corn is fed during the winter months some protein rich feed should be fed to balance the ration.

Feeds not mentioned in the above rations may be used, but those outlined may be safely taken as a guide in the making up of the ration.

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Insecticides and Fungicides

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Object

Year by year the damage done to the crops of the farm, orchard, and garden by insects and fungous pests seems to be increasing. Some of these pests may be a blessing in disguise, in that the remedies used for their eradication have been beneficial in other important respects; but, in order that they may be successfully combated, it is essential that the farmer know how to fight them to the best advantage, and that he have a clear idea of the nature of the remedies employed and the precautions that must be observed in their use. The literature on the subject is voluminous, but it is scattered and not always accessible to those who require it. In this bulletin an attempt has been made to gather the information obtainable on the subject into one publication and present it in a manner which we hope will be helpful and will fill a long-felt want.

Introduction

To spray with any degree of success requires, besides a knowledge of the acting principle of the remedy which is being employed, a rather intimate acquaintance with the enemy which is being combated. The different classes of insects and fungous diseases do not show similar habits or characteristics. If they did, then the search for a remedy would resolve itself into a very simple one—the discovery of a single successful one would be sufficient. But as it is, a great many of these remedial compounds are required in plant economy, the absolute number needed depending largely upon the different ways in which insects and fungous diseases attack their food or host plants. This results largely from differences in anatomical and physiological structure of these little but often highly destructive animals and plants.

Classes of Insects.

Insects are arranged in two leading groups: (*a*) those which actually chew and swallow their food and have what the entomologist calls *biting mouth parts*, and (*b*) those which obtain their food by piercing the outer tissues of the plant

and sucking up the juice, called insects with *sucking mouth parts*. The first group of insects, among which we find grasshoppers, cucumber beetles, codling moth larvæ. currant worm, and a great many others, can be poisoned by covering the surface of the plant upon which they feed with some poisonous material; while the second group, since they do not eat the surface of the plant, but feed only on the inside juices, must be destroyed by means of some substance which will corrode their bodies, such as a caustic wash, or something which will fill up their breathing pores, smothering them, such as a powder; or else they must be killed by subjecting them to the effects of a poisonous, asphyxiating or a paralyzing gas.

This, then, divides insecticides into two groups: *food poison* and *contact poison* insecticides.

There are some insects of both the above groups, however, which, owing to their peculiar habits, nature of their host, inaccessibility, or other causes, require special treatment. Among these are the radish maggot, which attacks the plant below ground; the grain weevils which affect stored products; those which feed within the tissues of the plant such as the peach borer; the household pests; the animal parasites; and others.

Classes of Fungi.

A fungus is a plant which feeds upon other plants, and is thus a parasite. It begins with a seed (spore) which germinates and produces a growth after the fashion of an ordinary plant. Sometimes this growth develops wholly upon the surface of the plant or its fruit, as with the powdery mildew of the grape; while at other times it develops the greater part or all of its growth within the tissues of its host, just as happens in the case of the grain rusts and smuts, the downy mildew, and a great many others.

Fungi, then, can be classed as *external* and *internal*, and the method of dealing with them varies accordingly. Those of the first kind can be attacked and destroyed or checked by use of proper materials, but the second kind can be prevented only.

INSECTICIDES

FOOD POISONS.

Food poisons are that class of compounds which contain some poisonous substance that if eaten and absorbed by the system will cause death by its toxic action. The most commonly used material that produces this toxic effect is arsenic, but other materials may be and are used.

Arsenical Compounds.

Arsenic trioxide, known also as ratsbane, arsenious oxide, white arsenic, (As_2O_3) is the basis of many food poisons. It is a white powder, but occurs also in two crystalline forms. It is sparingly soluble in water, the solubility varying with circumstances. If water at 15° C. be shaken for a long time with the solids, 100 parts of the water will dissolve .28 parts of the crystalline and .92 parts of the powder, while if saturated solutions at 100° C., be cooled to 15° C., 2.18 parts of the crystalline and 3.33 parts of the powder form remain in solution. Water containing carbon dioxide, however, dissolves much greater quantities

than does pure water. White arsenic completely and readily dissolves in solutions of caustic alkalies, such as ammonia, and in solutions of alkaline carbonates, such as washing soda. To both plants and animals it is, along with its compounds, a powerful poison, two or three grains being sufficient to cause death with the human being. Cultural solutions containing 0.0002 per cent. will destroy plant life.

Arsenic pentoxide, (As_2O_5) also called arsenic oxide, is likewise the basis of many food poisons. It is a white, solid substance slowly soluble in water. It is also a strong poison, but not so active as the arsenious oxide. Cultural solutions containing as much as 0.02 per cent. will allow the growth of plants still to continue.

What is important to know about arsenious and arsenic oxides in this connection, however, is that with water they form acids. For this reason they cannot be used directly as sprays for they would burn and destroy foliage; they must have their acid or scorching property removed. This is done by combining them with such substances as calcium, copper, lead, barium, etc., which change them into *salts*. The salts formed from arsenious oxide are called *arsenites*, e.g., calcium arsenite, while those formed from arsenic oxide are called *arsenates*, e.g., calcium arsenate. These salts retain the poisonous property of the arsenious and arsenic oxides and can be sprayed on to foliage without fear of doing any considerable harm.

But all salts of arsenious and arsenic oxides cannot be used for spraying purposes. Those which are *soluble in water*, such as sodium arsenite and sodium arsenate, cannot be employed. *Only those which do not dissolve but remain in suspension as solid particles* are of use. Following is a discussion of the most commonly used salts of arsenic.

Paris Green.

This substance was at one time used as an insecticide more largely than any other in the Province of Ontario, due to the fact that it was the first introduced, and, therefore, better known. It is an olive green material consisting of a compound of arsenic, copper, and acetic acid or "vinegar," called by chemists copper aceto-metarsenite, along with varying quantities of other substances present as impurities. Theoretically, pure Paris green contains 58.65 per cent. arsenious oxide (As_2O_3), 31.29 per cent. copper oxide (CuO), and 10.06 per cent. acetic acid. Commercially, however, these proportions do not obtain, since there is always a small amount of moisture present in the green together with some sodium sulphate or Glauber salt and white arsenic, compounds formed in the process of manufacture and never afterwards completely removed. The first two substances have no insecticidal value, and if present in more than normal quantity only increase the cost of the green and should be classed as mere "make weights." If care is used in the manufacture, there is no reason for them being present in more than very small amounts.

Free or Soluble Arsenious Oxide in Paris Green. It is on account of the presence of this substance in Paris green that we sometimes find that after spraying, the leaves of the plant treated turn black, having the appearance of being burnt, or even, in more extreme cases, drop off altogether, leaving the plant defoliated. This, of course, is very objectionable, since the physiological functions of the plant are thus severely checked, a case where the cure is as bad as, or worse than, the evil.

To account for the occurrence of this scorching, J. K. Haywood, of Washington, D.C., states three causes.*

* U.S. Department of Agriculture, Bureau of Chemistry, Bull. 82, pp. 5-6.

(1) There may be a certain amount of arsenious oxide over and above that combined with the other constituents. This is "free" arsenious oxide and until recently it has been considered the only cause of the scorching of the foliage by Paris green.

(2) The green may be poorly made, so that the constituents are very loosely held together. When such greens are brought in contact with water, especially water containing carbon dioxide, they soon break up and arsenious oxide is set free. Between the water of the spray and the action of dew and rain, enough oxide may be liberated to severely scorch the foliage.

(3) The green may be extremely fine. The best greens when ground to a fine powder and applied to foliage will scorch. This is doubtless due to the fact that more surface is exposed to the action of water which, containing carbon dioxide, would soon set enough arsenious oxide free to cause serious damage.

Following up these statements, however, Mr. Haywood says: "It is a very common occurrence to secure a commercial Paris green that scalds because of one of the first two causes, but the writer has never found a commercial sample of green that scorched because it was in too fine a condition."

As to the breaking up of Paris green when in contact with water, with the liberation of free arsenious oxide, Colby, of California,* expresses some doubt, since, as he says, "aceto-arsenite of copper, as manufactured to-day, is instantaneously precipitated from complex solutions containing alkali and often excessive quantities of various acids." However this may be, we do know that Paris green often destroys foliage, and that it is likely due to free arsenious oxide. There is no sure and ready method by which the free arsenic content of Paris green can be ascertained. Reagents, such as ammonia, which dissolve Paris green also dissolve the oxide almost or quite as readily. The microscope has been highly recommended, especially for the detection of "white arsenic" which has been added as an adulterant, but not for that which has been retained in the process of manufacture. No doubt this is a valuable aid, still the actual amount present cannot be determined in this way, and the only way to decide whether this substance is present in injurious quantities is by chemical analysis, or by actual trial in a small way.

Precautions in the Use of Paris Green. Since the method of estimating the free arsenious oxide of Paris green is not within the ready reach of all, it is well to assume that it is present in harmful quantities and to use something to alleviate the difficulty, if such there be. As before stated, arsenious oxide, or "white arsenic" may be combined with other substances which will neutralize or destroy its acid or burning property. Lime is one of these substances. *If a double quantity of good, freshly slaked lime or hydrated lime be mixed with the Paris green and then the mixture made into a paste with water and allowed to stand in this form some little time before diluting and spraying, the lime will combine with the greater part of the free arsenious oxide and remove its leaf scorching property to a great extent.*

It is well also to know that some kinds of foliage are much more susceptible to the destroying power of arsenious acid than others; thus the peach tree has foliage which is remarkably tender, whereas the foliage of the apple is very hardy. From investigations carried on in 1902-3, the results of which are embodied in Bulletin 82 of the Bureau of Chemistry, Washington, D.C., J. K. Haywood was enabled to make out a schedule showing the amount of free arsenious oxide which the foliage of the more common fruit trees will withstand.

* College of Agriculture, Bull. 151, p. 19.

His results, which also give figures showing the influence which lime exerts, and are thus doubly valuable, are summarized in the following table:

Average Percentages of Soluble Arsenious Acid Allowable.

	Apple	Pear	Peach	Plum
Without Lime	6	6	0	4
With Lime	7	7	4.5	6

This shows plainly that the orchardist must consider the kind of foliage he is spraying as carefully as the kind of Paris green he is using.

Total Arsenious Oxide in Paris Green. Since Paris green owes its insecticidal value to the arsenic which it contains, it follows that the larger the proportion of arsenious oxide there is present in it, the more effective it will be when used against insects. The value of any arsenical is determined by its arsenic content. Pure Paris green contains 58.65 per cent. As_2O_3. Any quantity above that must be present in the free state, and any quantity below that lowers the insecticidal, and, thus, the market value, just to the extent to which it is deficient. The commercial article is never ideal; in reality its manufacture is difficult, and many chemicals enter into the process. However, from analyses which we have made here and from results obtained elsewhere, most Paris greens contain at least 56 per cent. and there is no reason why they should contain less than 56 per cent. of arsenious oxide, providing any reasonable degree of care be exercised in the making.

Total Copper Oxide in Paris Green. Copper aceto-metarsenite contains 31.29 per cent. CuO, which bears a relation to the total arsenious oxide present of 1:1.87. Since it is necessary that arsenious oxide be combined with copper in order that it be not in the free state, then, any result of analysis showing a greater factor than 1.87 indicates free arsenic. White arsenic cannot be added as an adulterant without seriously disturbing this ratio.

Physical Conditions. The best grade of Paris green is a powder which will pass through a sieve of not less than 100 meshes to an inch. A coarse green is one that will settle rapidly from its suspension in water and will require constant agitation during the spraying operations in order that it may be distributed evenly over the foliage.

Adulterants and their Detection. The more common ones occurring in Paris green are white arsenic, barium carbonate, barium sulphate, gypsum, and road dust. The white arsenic may be added to bring the arsenic content up to the standard, but the presence of any of them is fraudulent, and they can only be classed as mere "make weights" which increase the cost of purchase for actual insecticidal value received. As previously stated, added white arsenic may be detected under the microscope, when it appears in the shape of white octahedral crystals. The other adulterants mentioned are all insoluble in ammonia, thus any quantity of residue left on dissolving the green in ammonia gives good ground for rejecting a sample on account of adulteration. This test is simple and can be applied by any one. A teaspoonful of the sample is placed in some receptacle, preferably glass, and about ten teaspoonfuls of strong ammonia (sp. gr. .90 = 25° Bé.) added and the whole then thoroughly stirred and left to stand for half an hour. The Paris green readily dissolves to form a deep blue solution, whereas the adulterants present are left as solid particles in the bottom of the vessel. As before stated, white arsenic is also quite readily soluble in ammonia, and a complete solution does not show the absence of this material.

Paris Green in Ontario.

The consumption of Paris green in this province amounts to between 100 and 120 tons annually. Although the demand is so good, still the product put upon the market is of a very favourable quality. Samples analyzed from time to time in the Department of Chemistry of this College show all greens to be well made and of an entirely satisfactory standard.

Composition of Some Paris Greens Analyzed at the O. A. C.

No.	Moisture 110°C	Sand	Sod. Sulphate	Copper oxide	Total arsenious acid As_2O_3	Acetic acid by difference	Soluble arsenious acid As_2O_3	Ratio $CuO:As_2O_3$
1	1.29	.11	.34	30.68	56.55	11.03	2.36	1: 1.84
2	.99	.23	.13	31.62	56.91	10.12	2.73	1: 1.79
3	1.25	.26	.37	30.59	56.8	10.73	2.11	1: 1.86
4	1.26	.15	.36	30.39	56.12	11.72	2.85	1: 1.85
5	1.29	.71	.57	30.23	56.01	11.19	2.73	1: 1.85
6	1.41	.12	1.80	30.29	56.33	10.05	4.35	1: 1.86

These greens are all as satisfactory as we can expect the commercial article to be. No. 6 contains somewhat more sodium sulphate than there is any need for, and is also somewhat high in soluble arsenious acid; otherwise there are none of them but could be highly recommended for spraying purposes.

London Purple.

London purple is prepared by boiling a purple residue from the dye industry, containing free arsenious acid, with slaked lime. In this way calcium arsenite and calcium arsenate are formed, and these are the poisonous compounds of this insecticide. As the dye residue has accumulated some dirt during the process of manufacture, a sandy substance will always be present in the London purple. It will thus be seen that London purple consists of calcium arsenite, calcium arsenate, a dye residue, and small amounts of sand and moisture. In case not enough lime is added to the dye residue, or the boiling is not continued long enough, varying quantities of the arsenious acid will be left in the free condition, and thus in a form which will scorch the foliage to which it may be applied.

According to Haywood,* about one-third of London purple is made up of the dye residue, sand, and moisture, and that it contains from 31 to 51 per cent. of total arsenic, figured as arsenious oxide; whereas Paris green contains the equivalent of about 56 per cent. of the arsenious oxide. The value of this insecticide will thus be in proportion to these two figures. However, one other point must be considered in valuing this substance, that is, its effect on foliage. According to Haywood, a very much larger amount of the arsenic of London purple is soluble in water than with Paris green. It seems probable that a part of this is made up of calcium arsenite and arsenate which have gone into solution, but at the same time, it is safe to say that Paris green is the safer insecticide. *The addition of lime to London purple is even more essential than with Paris green.*

Commercial Substitutes for Paris Green.

The fact that the use of lime along with Paris green and London purple is so generally recommended, and has been for some years, has led, from time

* U. S. Department of Agricultural, Bureau of Chemistry, Bull. No. 68.

to time, to the introduction of a number of substances to take their place. Many of these substances are poor substitutes, containing very little or no arsenic and often no appreciable amount of any other kind of poison. These have come on the market under a variety of names such as "Black Death," "Bug Finish," "Kno Bug," "Slug Shot," etc. One of the most successful of these materials has been a substance known as "Bug Death." A number of samples of this remedy have been analyzed here and the following two results are given as typically showing its make up:

	(a)	(b)
Moisture	0.32	0.38
Volatile matter	2.67	2.87
Sand, etc	3.17	4.26
Lead oxide	3.17	4.70
Zinc oxide	87.47	83.04
Iron oxide	3.84	4.09
	100.64	99.34

It is composed largely of crude zinc oxide with small quantities of lead oxide and iron oxide. It also contains nitrogen equivalent to about one-half of one per cent. of ammonium sulphate. This latter substance is a plant food; but there is so little of it in the mixture that it cannot have much value. Bug Death has considerable fungicidal value, and destroys the bugs. It has to be applied in fairly large quantities and is rather an expensive substance; but it has given good results when used on potatoes.

But there are a number of remedies which have been put out from time to time which have become real and successful substitutes for the older standard remedies. So successful, indeed, have some of these been that they have almost superseded in use the earlier poisons. The *most important* of these are those which contain large quantities of arsenic, and commonly called commercially the "arsenoids." They are invariably either arsenates or arsenites. Among them we have copper arsenite (green arsenoid), lead arsenite (pink arsenoid), barium arsenite (white arsenoid), calcium arsenite, calcium arsenate, lead arsenate and zinc arsenite. A sulphide of arsenic has also been used with some success. Only the more important of the above will be discussed, and the following few pages give a short description of those most commonly and successfully used.

Lead Arsenate.

This arsenical has become very popular and is replacing Paris green to a great extent. This is because it is much safer to apply than Paris green, especially on the more tender foliage, such as peach; and further, because it stays longer suspended in water on account of its extremely finely divided condition, and that it adheres more firmly to bark and foliage, and therefore exerts its influence over a longer period of time. It also can be safely mixed with lime-sulphur solution, while Paris green cannot.

There are three forms of lead arsenate, the PbH or acid lead arsenate ($Pb\ H\ As\ O_4$), the Pb_3 or neutral lead arsenate, $Pb_3\ (As\ O_4)_2$), and the Pb_5 OH or basic lead arsenate—($Pb_5\ OH\ (As\ O_4)_3$).

It is not known definitely which of these is the best form to use; all three, if well made, are quite insoluble in water.

The following table* shows the composition of these three forms of this arsenical, calculated on a water free basis:

Composition of the Three Forms of Lead Arsenate.

Constituent.		Acid.		Neutral.		Basic.
Lead Oxide, PbO		64.291		74.440		75.924
Arsenic Oxide, As_2O_5		33.114		25.560		23.463
Equiv. to As (%)	21.590		16.667		15.299	
Ratio, As_2O_5; PbO	1:1.942		1:2.912		1:3.236	
Water of Combination		2.595		0.000		0.613
		100.000		100.000		100.000

The acid form is the richest in poisonous material (As_2O_5) and therefore would seem to be the best; but, on the other hand, it seems to be the general opinion that the neutral and basic forms are the safer to use with lime-sulphur solution, a combination in which this arsenical is often necessarily applied, since they are not so likely to decompose the wash nor to themselves break up and liberate soluble arsenic. The formation of soluble arsenic would, of course, make the wash injurious to foliage, and the decomposition of the lime-sulphur solution would lower its efficiency as an insecticide or fungicide. It is doubtful, however, that any of the lead arsenates tend to produce any appreciable amount of soluble arsenic in the presence of lime sulphur, since examinations we have made here have never indicated such; but destruction of an extensive amount of the sulphide sulphur of the lime-sulphur does take place, in fact, the acid lead arsenate destroys as high as 30 per cent. of this valuable part of the sulphur content of the lime-sulphur wash, almost as much as does Paris green (32-33 per cent.). So too, does the neutral lead arsenate, but only to the extent of about 8½ per cent. and thus not a very serious matter. We have never studied the basic form in this connection, but it is quite probable that it would have a less effect than the neutral, and certainly, at least, not more.

The destructive effect of acid lead arsenate on lime-sulphur can be lowered to a point no greater than that of the neutral by mixing with it three and a half parts of fresh hydrated lime at the time of making the spray, and unless this is done it is advised that when using lead arsenate and lime-sulphur in combination that either the neutral or basic form of the arsenate be used.

Following is a table showing the effect of acid and neutral arsenate of lead on the sulphur content of lime-sulphur wash. It also shows the effect of the use of three and a half parts of hydrated lime along with the acid arsenate in reducing the loss of dissolved sulphur. As a point of added interest the effect of calcium arsenate, Paris green, and of hydrated lime on the dissolved sulphur of the lime-sulphur wash is also included.

It is seen that the use of hydrated lime along with the acid arsenate of lead reduces the destruction of dissolved sulphur down to a point where it amounts to about the same as that caused by the neutral arsenate of lead.

It is also interesting to find that the destructive effect of Paris green on the dissolved sulphur of lime-sulphur wash is also largely counteracted by the presence of lime. Using 6.6 parts of hydrated lime to one part of Paris green lowers the loss from 33.27 per cent. down to 7.22 per cent. But it must be pointed out here that this treatment does not render the Paris green-lime-sulphur combination

*Mass. Agr. Expt. Sta. Bull. 201.

a safe mixture to use, and the use of Paris green with lime-sulphur is at no time to be recommended.

Effect of arsenates of lead, calcium arsenate, hydrated lime, acid arsenate of lead+hydrated lime, and Paris green+hydrated lime on the dissolved sulphur content of lime-sulphur wash.

Material added to the L.S. wash S.G. of wash 1.008	Rate lbs. per 40 gals.	Total dissolved sulphur per 100 c.c. spray (gms.)	Amount of dissolved sulphur destroyed per 100 c.c. spray (gms.)	Per cent. of dissolved sulphur destroyed
1 Acid lead arsenate	1.90	.6554	.2740	29.52
2 Neutral Lead arsenate	2.50	.8480	.0814	8.76
3 Calcium arsenate	1.16	.8779	.0515	5.54
4 Paris green	1.00	.6202	.3092	33.27
5 Hydrated lime	6.60	.9240	.0054	.058
6 Acid lead arsenate	1.9			
Hydrated lime	6.6	.8568	.0726	7.81
7 Paris green	1.0			
Hydrated lime	6.6	.8623	.0671	7.22
8 Check	....	.9294	.....	.....

Some investigators claim that a fourth form of lead arsenate exists, viz., the pyro arsenate of lead ($Pb_2 As_2 O_7$). Its presence or the extent to which it occurs in our lead arsenates is unsettled. It is a form which is fully as rich in poisonous material as acid arsenate of lead is, but it is not such a stable substance as the latter and would readily break up when mixed with water, especially alkaline water, or with lime-sulphur solution, and liberate arsenic acid. It would thus be extremely destructive to foliage. Not enough complaint is on record, however, to warrant us in believing that any quantity of the pyro arsenate is present in our lead arsenates.

Commercial Lead Arsenate. This term is applied to those brands of lead arsenate which are manufactured by various chemical companies or firms. The commercial brands come on the market in two forms, as the *paste* and as the *powder*. The former has enough water in it to keep it in a moist and pasty condition, whereas the latter is dry and in the form of a powder. The manufacturer of the paste usually sells on the 40 per cent. water basis, i.e., that his product will contain forty pounds of water in every one hundred pounds. But this will vary slightly up and down for the same brand. Among different brands the range runs from 25 to 50 per cent. of water. The powders run about ½ to 1 per cent. In arsenic ($As_2 O_5$) the powders are fairly constant, varying only with the form of the lead arsenate, whether it be basic, neutral or acid; while the pastes, besides varying from the same factor also vary with the water content, and thus show a wider difference in arsenic content. If a limit were given for arsenic content it would be that the pastes should not go much below 15 per cent. and the powders 23.0 per cent. $As_2 O_5$. The pastes were the first to come on the market because it was claimed for them that they could be worked up more readily with water and into a more finely divided condition. Because of this they would require less agitation in the spray tank, and would adhere more firmly to bark and foliage. This advantage was always largely over-estimated, however, and at the present time has entirely disappeared. The powders are now produced in such a fluffy and finely divided form (70-80 cubic inches per pound as compared with 40 cubic inches formerly) that they are, if anything,

superior to the pastes in mixability with water and adhesiveness. Further than this, the powders are less bulky to handle, and in this way result in a material saving in cost of containers and transportation; they also are less subject to loss by leakage or to injury on storage—frzeeing and thawing destroying, in great part, the suspension power of pastes. The powders are also more uniform in their composition, varying only within narrow limits in regard to their moisture content, whereas the pastes vary as much as 25 per cent. among different brands. This latter point is very important when it comes to weighing out the required quantity of lead arsenate to use. A pound of lead arsenate paste containing 25 per cent. of water will contain half as much again of actual lead arsenate as a pound of lead arsenate paste containing 50 per cent. of water. If the manufacturer of pastes would ship his output with always 40 per cent. of water in it as nearly as he can make it, and if the user would keep it from drying out after he buys it, the above difficulty would of course be overcome. If the buyer uses the paste form he should keep a layer of water over its surface all the time in order to keep it from drying out and to maintain its water content uniform. On the whole, the many advantages of the powders over the pastes has led, in great measure, to the displacement of the latter from popular favour. The recent introduction of the dusting practice has also further served to popularize the former.

The composition of some of the more common commercial lead arsenates is given in the following table:

Composition of Lead Arsenate.

Station No.	Brand	Paste or Powder	Water H_2O	Lead Oxide PbO	Arsenic Oxide As_2O_5	Figured to Dry Basis		Water-Soluble Arsenic-Oxide As_2O_5
						Lead Oxide PbO	Arsenic Oxide As_2O_5	
			%	%	%	%	%	%
*347	Grasselli.....	Paste...	40.49	40.33	16.74	67.78	28.14	0.24
†15015	Grasselli.....	Paste...	38.83	42.70	17.43	69.81	28.49	0.39
*346	Grasselli.....	Powder..	0.53	68.14	27.15	68.50	27.29	0.35
*349	Sherwin-Williams..	Paste...	50.48	35.02	13.68	70.72	27.62	.....
*835	Sherwin-Williams..	Paste...	42.07	42.25	13.97	72.67	24.03	0.29
†15065	Sherwin-Williams..	Powder..	.....	64.29	32.36	.....	.....	0.75
†372	Hemingway.....	Paste...	48.32	32.90	16.63	63.67	32.18	.....
†15084	Hemingway.....	Paste...	48.45	32.72	16.98	63.47	32.94	0.39
*306	Niagara.....	Paste...	24.23	54.49	18.54	71.92	24.47	.....
*373	Swifts.....	Paste...	45.14	34.80	17.77	63.44	32.40	.....
*436	May and Baker...	Paste...	47.24	30.56	16.43	57.93	31.14	.....
*555	E. Merk.....	Powder..	1.01	73.43	23.63	74.17	23.87	.....
†15089	Thomsen.....	Paste...	48.52	33.34	15.78	64.76	30.65	0.36
†15041	Thomsen.....	Paste...	41.39	39.24	17.23	66.95	29.39	0.98
†15050	Vreeland.....	Paste...	38.91	39.17	19.43	64.12	31.81	0.30
†15051	Vreeland.....	Powder..	.....	64.15	32.50	.....	.....	0.41
*832	Canada Paint Co..	Paste...	48.33	37.10	13.84	71.60	26.71	0.26
*834	Berger & Sons.....	Paste...	48.64	38.15	11.25	74.39	21.94	0.13

From a perusal of the above table it will be noted that the paste lead arsenates vary considerably in respect to the amount of water which they contain, especially among the different brands, these ranging from 24.23 per cent. to 50.48 per cent.; and even the same brand is not always constant in this regard.

*Analysis made by the Department of Chemistry, Ontario Agricultural College.
†Analysis made by the New Jersey Agricultural Experimental Station, Bulletin No. 286.

It is because of this factor, as before noted, that it is impossible to state definitely what quantity of paste lead arsenate should be weighed out in order to get a spray of known strength.

Another thing to be noted from the above table is that the majority of the brands here given are composed of a mixture of the various forms of lead arsenate, viz., basic, acid and neutral. This can be seen by an examination of columns seven and eight showing the percentage amount of lead oxide and arsenic oxide by weight present when calculated to the dry basis. If the sample is made up entirely of neutral lead arsenate the percentage amount of lead oxide will be about 74, and the percentage amount of arsenic oxide will be approximately 25, whereas, if the sample is composed of acid lead arsenate the percentage amount of lead oxide and arsenic oxide will be about 64 and 33 respectively. Should the basic form be the arsenate present there would be about 76 per cent. of lead oxide and 23 per cent. of arsenic oxide. If the sample be composed of a mixture of these arsenates then the percentage amount of these two constituents would lie in between the upper and lower limits for each, viz., between 23 and 33 for $As_2 O_5$, and between 64 and 76 for the lead oxide. The exact amount of each of these will be in ratio proportionate to the amount of each kind of arsenate present. Thus it will be seen that Hemingway and Swift arsenate of lead are practically made up solely of the acid lead arsenate, the Niagara and Merck of neutral lead arsenate, the Berger & Sons of basic lead arsenate, and the other brands listed a mixture of the various varieties, usually.

Lead arsenates should be of such a quality that when mixed with water they will give only inappreciable quantities of soluble arsenic, not more than 0.75 per cent. Samples which, when boiled with ammonia water, will give in the filtrate a precipitate with lead acetate and acetic acid, are as a rule injurious to foliage. The addition of a solution of lead acetate or nitrate to such arsenates till there is an excess of lead, as shown by potassium iodide paper (see under home-made lead arsenate), would be beneficial.

Home-made Lead Arsenate. If one cares to he can make his own lead arsenate at home. The only drawback to this is the assurity of obtaining materials of suitable quality. Bulletin 131, Bureau of Chemistry, U.S. Department of Agriculture, gives the following directions:

Formula A.	Ozs.
Sodium arsenate (65 per cent.)	8
Lead acetate (sugar of lead)	22
Formula B.	
Sodium arsenate (65 per cent.)	8
Lead nitrate	18

"If the sodium arsenate employed is 50 per cent. strength, use ten and a half ounces instead of eight. Of the pure crystallized salt fourteen ounces would be required to furnish the same amount of arsenic oxide as would be furnished by the given amounts of the 50 and 65 per cent. grades if they actually contained these per cents. In only one technical sample examined, however, was the arsenic oxide content over 45 per cent. The formulas are based on lead acetate containing 60 per cent. of lead oxide and lead nitrate containing 66 per cent. of lead oxide.

"*Dissolve each salt separately* in from one to two gallons of water* (they dissolve more readily in hot water), using wooden vessels. After solution has

*The solution of lead acetate may have a milky appearance. This will be no objection, and it need not be filtered.

taken place, pour slowly about three-fourths of the lead acetate or nitrate into the sodium arsenate. Mix thoroughly and test the mixture by dipping into it a strip of potassium iodide test paper,† which will turn a bright yellow if lead is in excess. If the paper does not turn yellow, add more of the lead acetate slowly, stirring constantly, and test from time to time. When the solution turns the paper yellow sufficient lead salt is present, but if it should occur that the paper does not turn yellow after all the lead salt has been added dissolve a little more and add until an excess is indicated. The great advantage of this test is that it is not necessary to filter the solution or wait for it to settle.

"If the paper is not at hand, the test may be made by adding a few drops of a solution of potassium iodide, when, if lead is in excess, the instant the drops touch the solution a bright yellow compound, lead iodide, will be formed.

"It is very essential that the lead salt be added in *slight excess*, but a large excess should be avoided.

"If the material has been carefully prepared with a good grade of chemicals it will not be necessary to filter and wash the lead arsenate formed, though it would be a safe precaution to allow the lead arsenate to settle, then decant the clear solution and discard it. Approximately one pound of actual lead arsenate will be obtained by using the amounts of chemicals specified, which is equivalent to practically two pounds of commercial lead arsenate in the paste form. It may be made up to forty gallons with water if a formula is being used which calls for two pounds of commercial lead arsenate paste to forty gallons, or if a stronger application is desired add less water.

"As these chemicals are all extremely poisonous, vessels in which they have been dissolved or mixed should be plainly marked, and not used for any other purpose."

The authors of the above publication claim that Formula A will produce neutral lead arsenate and Formula B acid lead arsenate.

The economy of making home-made lead arsenate will depend on the cost of materials, labour, convenience, ability to secure the chemicals of suitable quality, etc.

Amount of Lead Arsenate to Use. The amount of lead arsenate to use in spraying varies all the way from one to six pounds per forty gallons (either water, lime-sulphur solution, or Bordeaux mixture), according to published formulæ. Using Paris green (56 per cent. $As_2 O_3$) as the standard spray, applied at the rate of one pound per forty gallons, however, lead arsenate in the different forms should be applied in the following strengths:

Kind	Condition	Pounds per 40 gallons
Neutral	Paste	4⅘
Neutral	Powder	2⅔
Acid	Paste	3⅗
Acid	Powder	2
Basic	Paste	4⅔
Basic	Powder	2⅘

The above quantities are estimated on the basis that the paste will contain 40 per cent. of water; and that the neutral lead arsenate in the paste and powder form will contain 15 and 25 per cent. of $As_2 O_5$ respectively; and that the acid

†If potassium iodide test paper cannot be obtained, it may be prepared by dissolving a few crystals of potassium iodide in about a teaspoonful of water and saturating filter paper or blotting paper with this solution. After the paper has dried, cut into strips and keep dry until needed.

lead arsenate in the paste and powder form will contain 19½ and 33 per cent. of $As_2 O_5$ respectively; and that the basic lead arsenate will contain 14 and 23 per cent. $As_2 O_5$ respectively. As these percentages vary up and down from these averages, however, and since some lead arsenates are a mixture of forms these amounts will have to be varied accordingly. In addition to this the fact must not be overlooked that Paris green is a more active poison, pound per pound of arsenic present, than is lead arsenate, through the fact of it being an arsenite. For this reason the amount of lead arsenate to use should be slightly greater than the quantities given. However, so many factors determine or modify the strength of poison to be used at any given time, as, for example, the insect to be attacked, the seriousness of the infestation, the kind of plant, the time of year, the weather conditions, etc., that no hard and fast rules can be given as to quantities to use. The above amounts, therefore, are only meant to be suggestive.

Calcium Arsenite.

This is a home-made substance and several formulæ have been published for making it. There seems to be no doubt about the insolubility of the compound when it is used immediately after it is prepared, but when allowed to stand for days or weeks before applying there may be some decomposition take place and soluble arsenites be formed which will destroy foliage.

The following method can be followed in making it:

White arsenic ($As_2 O_3$)	5 pounds.
Washing soda, crystallized ($Na_2 CO_3 10H_2O$)	5 pounds.
Water (soft, such as rain water)	2½ gallons.

(In place of the crystallized washing soda one can use instead one and a half pounds of the anhydrous washing soda. It is a white powder. The crystallized washing soda changes into it after long exposure to the air, so that it is a common thing, therefore, to find that the crystallized washing soda after bought changes, if kept in an open container, to the anhydrous form. The so-called soda ash, which can be bought and which looks like anhydrous washing soda, is not suitable for making calcium arsenite.)

The washing soda and white arsenic are added to the water. The mixture is then brought to the boiling point and boiled till everything is dissolved. This takes about five minutes of boiling. When solution is effected, about eight pounds of good fresh lime are added. When slaking has ceased, continue boiling for 10-15 minutes. This mixture, when diluted with water, will make about 800 gallons of spray. It can be made in smaller quantities if so desired, by reducing the quantity of white arsenic, washing soda and lime given above, but still retaining the same proportions. If stone lime is not to be had, hydrated lime can be used in its stead. Should hydrated lime be used, however, ten and a half pounds must be taken and the boiling continued for twenty minutes.

The chief advantages of the calcium arsenite preparation is that it is cheap, the materials are easily procured, it is easily prepared, and that it is a reliable and fairly safe insecticide.

Calcium Arsenate.

This arsenical was introduced about eleven years ago. The idea in mind at that time, mainly, was to get an arsenic compound which would mix well with lime-sulphur, the old standard arsenicals up to that date having been found not to be ideal in all respects or, in some cases, entirely unsuitable. Both

lime-sulphur and the lime arsenate being calcium compounds it was deemed that they should present the nearest approach to compatibility. It was soon found, of course, to be a decidedly efficient and suitable food poison, and at that time comparatively cheap. The result is that it has probably come to stay. Indeed, it is now used practically as a specific in the United States for the cotton boll weevil. The late war, with resulting high prices, brought it into great prominence because the copper and lead compounds became more inflated than those of calcium.

There are three separate products:

(1) Acid.....$Ca\ H\ As\ O_4 . H_2O$.
(2) Neutral.....$Ca_3\ (As\ O_4)_2 . 2\ H_2O$.
(3) Basic.....Variable formula, according to the amount of excess of lime.

The third one is the commercial article, and it comes on the market both in the dry or powder form, and as the paste carrying about 50 per cent. of water.

The composition of commercial arsenate of calcium is as follows:

Calcium oxide (CaO).....	44.128 per cent.
Arsenic oxide ($As_2\ O_5$).....	45.238 per cent.
Equivalent to As 29.497 per cent.	
Ratio $As_2\ O_5$: CaO— 1: 0.975.	
Combined water.....	10.634 per cent.
	100.000 per cent.

If the paste form is used then the above percentages become approximately one half that given.

It is thus seen that the dry form of this arsenical carries about two-thirds as much arsenic as does Paris green (44.35 per cent.); but it would not be so effective, in proportion, as the latter remedy, which is an arsenite. It will be safer to use on foliage than Paris green, the excess of lime in the basic form making the calcium arsenate in it more stable; and at the same time it is useable with lime-sulphur, liberating no appreciable amount of soluble arsenic, and only destroying 5½ per cent. of the dissolved sulphur of the summer wash.

It is a white powder, bulky, giving 80-100 cubic inches to the pound. It has good suspension and adhesiveness and can be easily prepared for spraying. Calcium arsenate also forms a good dust, alone or in mixtures.

Zinc Arsenite.

This arsenical was brought out about twelve years ago, but has never come into general use as yet, mainly because of its costliness. It was first made in California, and the long shipment and the incident freight charges made the price almost prohibitive to the Ontario consumer. However, it is at present made nearer home (Baltimore, Md.), and the cost will not now be so great.

Two samples have been analyzed in this laboratory for total arsenic, and the percentage amount found to be 36.63 and 42.0 respectively, expressed as $As_2\ O_3$. A New Jersey analysis (Bulletin No. 286) gives the amount of $As_2\ O_3$ found as 30.58 per cent. in a sample secured by them from the Thomsen Chemical Company of Baltimore. Giving 36.0 per cent. as about the average it will be seen that zinc arsenite is a little less than two-thirds as poisonous as Paris green. Hence, about half as much again should be used.

This insecticide comes in the form of a greyish-white powder, rather moist, and is easily worked up into the water in preparation for spraying. It can be mixed with safety with lime-sulphur solution, and therefore lends itself well to combined summer spraying.

Stomach Poisons Not Arsenicals.

There are a number of substances which could no doubt be included under this head. Some substances act both as a stomach poison and as a contact poison, and it is sometimes hard to draw the dividing line and decide on which side to place any given material. But if a substance acts more strongly as the first then it would be well to class it in that division, and vice versa, i.e., if a substance has stomach poison properties, but not potently so, it is well not to depend on its use as such, but to adopt a more certain remedy, and vice versa.

Hellebore.

White hellebore is a powder obtained by grinding up the dried roots of a plant known as Veratrum album, and green hellebore that of V. viride. Each comes on the market as a grey powder usually, but sometimes it has a light yellowish colour. The powder possesses a rather pleasant odour and contains as its active principle a very powerful alkaloid, called Jervine, along with other alkaloids. The total content of these poisons is about 1 per cent. Hellebore is much less poisonous than the arsenicals, and hence is only used in special cases. These special cases are denoted by the fact that the alkaloids responsible for the activity of this insecticide are poisonous to insects, but in the quantities ordinarily used not of any serious action on man. This means, of course, that it could be used as a remedy on fruits and vegetables about to ripen or soon to be eaten, or as a combatant for insects infesting the household.

The alkaloids of hellebore are very volatile and the strength and efficiency is soon lost if exposed to the air. This means that it must be kept in tightly closed containers and preferably used fresh.

It is applied as a spray, one ounce to two gallons of warm water; or dry, alone, or mixed with some diluent such as flour or finely divided air-slaked lime in the proportion of about one to five.

Hellebore is mainly a stomach poison, but no doubt has some efficiency as a repellant, and as a contact by clogging the breathing pores of the insect.

Miscellaneous.

It is very likely there are other remedies in use, e.g., tobacco extracts, black leaf forty, nicotine sulphate, etc., which act at least partly as stomach poisons, but whose chief actions are undoubtedly as contact poisons. They will thus be dealt with under that division.

Standard Formulæ for Application of Arsenicals.

There is a great difference in rapidity and killing power between arsenates and arsenites, as was partly shown when discussing arsenic trioxide and pentoxide in the earlier part of this bulletin. Because of this these two kinds of arsenicals cannot be compared fairly on the amount of arsenic contained. Arsenites are much more rapid and potent than arsenates. For this reason it is sometimes good practice to use a mixture of the two in order to get a quick action through the presence of the arsenite and the slower and more prolonged

action through the presence of the arsenate, e.g., a mixture of Paris green and arsenate of lead.

The following table represents basic quantities that may be used of each of the several kinds of standard arsenicals. However, they can and must be varied according to the insect and the seriousness of the attack, and according to the nature of the foliage on which they are to be placed:

Standard Formulæ for Application of Arsenicals.

Arsenical	Lbs. per bbl.	Oz. per gal.	Lbs. metallic As per bbl.
Arsenites:			
Paris green	.286	.114	.126
Arsenates:			
Dry acid lead arsenate	1.390	.556	.300
Dry neutral lead arsenate	1.810	.724	.300
Dry basic calcium arsenate	1.070	.428	.300

Using Paris green as a standard for arsenites, any arsenite of known composition may be applied in sufficient quantity to furnish the same amount of metallic arsenic per barrel, i.e., .126 pounds; and using any one of the three arsenates mentioned, as a standard for this class, any arsenate of known composition can be applied in quantity such as will furnish a like amount of metallic arsenic, i.e., .300 pounds per barrel.

*Arsenical Injury.**

After the application of an arsenical to foliage or to young and tender growth it often happens that considerable injury results. This is thought to be due, and undoubtedly is, to *soluble arsenic*, and is usually spoken of as *arsenical injury*. Carbon dioxide and ammonia of the atmosphere, in conjunction with dews, fogs, or light rains and high temperatures, will materially increase the amount of soluble arsenic and the consequent burning. When the arsenic is in solution in the spray liquid, or drops of rain or dew on the foliage, some of it is absorbed by the tissues of the leaf. A very minute amount may have no injurious effect, and that from an arsenate less than that from an arsenite, but if, on account of a high soluble arsenic content of the spray material, or to long standing of the liquid before drying, as will happen in humid weather, a sufficient amount has been absorbed, then the tissue will be killed.

Two types of injury are distinguished—*acute* poisoning and *chronic* poisoning. In cases of acute poisoning the leaf, or large areas of it, turns black within twenty-four hours after the application; or sometimes, when the insecticide has dried rapidly after application, the blackening may not appear till after the first period when water has stood on the foliage for some time. In chronic poisoning there are no definite lesions, but after two or three weeks the leaves prematurely turn yellow and drop off. Apparently in this type of poisoning not enough arsenic is absorbed to kill the cells outright, but yet enough to interfere with and finally stop the functioning of the cells.

Conditions favouring a rapid drying of the arsenical and its continuance in a dry state are propitious, i.e., a relatively high temperature, low humidity and a good circulation of air at the time of application. If this is followed by warm, dry weather, there should be a minimum of arsenical injury. On the

*Mass. Agr. Expt. Sta. Bull. 201.

other hand, factors conducive to solubility of the arsenic and its passage, by osmosis, into the substance of the leaf or twig are detrimental, i.e., warm, "muggy" weather, or warm weather accompanied by fogs or heavy dews. Rains are not necessarily injurious if heavy enough to wash off the soluble arsenic as soon as formed.

For most farm crops it is unwise to use an arsenical without protecting the plant against injury. The addition of milk of lime affords this protection. Four pounds of high-grade quick lime (95 per cent. CaO) are generally sufficient for one barrel of spray. The lime should be carefully slaked, sieved, diluted to nearly forty gallons, and the arsenical added slowly with thorough agitation immediately before application. Hydrated lime of good quality may replace the quick lime, using five and a quarter pounds, carefully sieved and worked up to a smooth paste with a small amount of water before making up to nearly the forty gallons.

CONTACT REMEDIES.

As previously stated, these remedies are employed to destroy sucking insects which must be killed by contact. They will kill any kind of insect with which they come into contact, however, and in this way are more or less general in their effectiveness. Nevertheless, the biting insects are, as a general thing, more efficiently controlled by means of the stomach poisons. It might be given as a rule that the weaker the surface tension of the spray, and the thinner the chitin of the insect, the more effective will any contact remedy be, other things being equal. *To be effective, the plant or tree must be very thoroughly covered, and in many cases the insect must be actually "hit."* This means that the under side of the foliage must be sprayed as well as the upper part. In the case of the San José scale, for instance, which may exist in a spot no larger than a pin head, one scale left untouched may produce as many as a million offspring in one season. Consequently, *thorough spraying is essential to success.*

A large number of various kinds of substances are used for contact purposes, some being gases, others either liquids or solids. The compounds used may act in any one or more of the following ways:

(1) Glue the insect down.

(2) Attack the body, dissolving fat and muscle, precipitating proteins, etc.

(3) Act as a narcotic, paralyzant or anaesthetic.

(4) Asphyxiate the insect by clogging up the breathing pores or, by saturating the body, prevent necessary aeration.

In any given case, however, it is usually difficult to define the exact way or ways in which a substance acts.

Sulphur.

Sulphur is a yellow substance which melts to a thin straw-coloured liquid at 114.5° C., and boils at 448.4° C., changing to a brownish yellow vapour. When these vapours strike a cool surface they are condensed and deposited as a fine amorphous yellow powder, called "flowers of sulphur." Sulphur also appears on the market in sticks called "sulphur rolls." When sulphur rolls are ground to a fine powder we have it in the form known as "flour of sulphur." *Flour* and *flowers* of sulphur are the two forms which are used for combating insects. They are used as a dust or, more often, boiled up with lime and water and applied as

lime-sulphur solution. Flour of sulphur is somewhat cheaper to buy than flowers of sulphur.

Lime-sulphur Washes.

These washes have come into use during the last twenty-five years, chiefly in combating the San José and other scales. They have also been found to be very effective in destroying other kinds of the smaller insects, and are considered by many to be one of the best general "cleaning up" sprays that have been devised. In addition to their insecticidal value, they are efficient fungicides.

A disagreeable feature of these washes is that they are very caustic, and their application is often attended with considerable discomfort, especially in windy weather. Some of the irritation to the face and hands of the operator may be avoided by smearing the former with vaseline and covering the latter with rubber gloves. Leather is easily corroded by these washes, and care should be taken that the spray does not come in contact with the harness. Unless it is a still day, the horses should be covered with blankets, or always kept to the windward.

Home-made Wash.

A number of formulæ have been recommended for the preparation of this wash. Those usually adopted in Ontario, as given by Prof. Lochhead,* are as follows:

Fresh lime	20 pounds.
Sulphur (flowers or flour)	15 pounds.
Water	40 gallons.

"With warm water make the sulphur into a paste, put in the lime and add about fifteen gallons of warm water with stirring. The sulphur paste may be added after the lime has been slaked. Boil *vigorously* for an hour in a kettle, or in a barrel with live steam. Make up to forty gallons with water; strain into spray tank and apply while warm."

Self-boiled Wash.

To make this wash it is essential to have a freshly burned quick slaking lime. The directions for making it as given by Mr. W. M. Scott, of the Department of Agriculture, Washington, D.C., are:

Lime	40 pounds.
Sulphur	40 pounds.
Water	200 gallons.

"Place the lime in a barrel and pour enough water (about three gallons per twenty pounds) to start slaking and to keep the sulphur off the bottom of the barrel. Then add the sulphur which should first be worked through a sieve to break up the lumps, and finally enough water to slake the lime into a paste. Considerable stirring is necessary to prevent caking on the bottom. After the violent boiling which accompanies the slaking of the lime is over, the mixture should be diluted ready for spraying, or at least enough cold water added to stop the cooking. Five to fifteen minutes are required for the process according to whether the lime is quick acting or sluggish. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into solution,

*Thirty-sixth Annual Report of the Entomological Society of Ontario.

but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the lime, and at the end of thirty or forty minutes enough of the reddish liquid is produced to burn peach foliage and even apple foliage in some cases. Hence the necessity for cooling the mixture as soon as the lime is well slaked."

This wash has been specially developed for summer spraying—it does not contain enough of the calcium polysulphide to cause any foliage injury.

Concentrated Wash—(1) Commercial:

The commercial concentrate is, as its name indicates, a wash manufactured by a commercial concern. It is made in large quantities by several firms and forms a very ready and convenient source of the lime-sulphur wash. The common brands on the market are: Niagara, Rex, Graselli and Sherwin-Williams. These do not differ materially from each other, the quality being practically uniform.

The concentrate is strong (concentrated), usually carrying between 25 and 26 per cent. of total dissolved sulphur, and needs to be diluted with water before spraying. To dilute properly it is necessary to use a hydrometer and obtain the specific gravity of the *clear liquid.* The greater the sp. gr., the larger is the quantity of water that must be added. A hydrometer for this work should have its scale graduated from 1.000 to 1.400, and preferably should also have the Beaumé scale marked on its spindle. A hydrometer of this kind can be secured at a nominal price from or through dealers in spray materials. The proper quantity of water to be added is found by dividing the decimal portion of the specific gravity by .028 for the winter wash, and .008 for the summer wash.

E.g., Specific gravity of concentrate — 1.320, ∴ each gallon can be diluted to

$$\text{(a)}\ \frac{.320}{.028} = 11.43 \text{ gallons for winter wash,}$$

$$\text{and (b)}\ \frac{.320}{.008} = 40.00 \text{ gallons for summer wash.}$$

The dilution for the spray, both winter and summer, will vary, however, depending on the fungus or insect being sprayed for, the nature of the foliage and the severity of the infestation. A spray calendar should therefore be consulted in order to find the correct figure to use in place of .028 and .008.

In case of the clear concentrates, i.e., those which contain no sediment or "sludge," it is sometimes desirable to add lime. The main function of the lime is to act as a marker so that the thoroughness of the spraying can be controlled. This is especially important when an inexperienced or careless man is at the nozzle. But it has other uses besides: (1) It prevents a great deal of waste by dripping, (2) some claim that it improves the sticking quality of the wash, (3) lime possesses in itself marked insecticidal and fungicidal properties. If lime is added it should be slaked first, worked up to a thin batter with water, strained free of large particles and then poured into and well mixed with the diluted wash. Never add it to the concentrate before dilution. The amount used varies from two to six pounds of stone lime per forty gallons of spray.

(2) Home-made:

It is quite possible to make the concentrated wash at home if one wishes to go to the trouble and expense for equipment. After some experience the wash

can be made of as good quality as the commercial kinds, and at less expense. Directions for making and handling are as follows (See Bull. 99, Penn. Expt. Station):—

50 pounds best stone lime,
100 pounds sulphur (flour or flowers),
40-45 gallons of water, *at finish.*

"Put eight gallons of water in kettle and start fire. Place lime in kettle. After slaking is well started, add the dry sulphur and mix thoroughly, adding enough water to maintain a thin paste, which requires about five gallons. After the slaking and mixing is completed, add water to the height of forty gallons on the measuring stick, bring to a boil and stir until the sulphury scum practically disappears. Then add water (preferably, but not necessarily, hot) to the fifty-five gallon height, and boil to forty-five gallons. The material should be kept well stirred, especially during the early stages of the process, and any lumps of sulphur or lime should be thoroughly broken up.

"The total time of actual boiling should be about one hour, though a ten-minute variation either way is not objectionable providing the sulphur is evidently dissolved. This fact is best determined by dipping and slowly pouring some of the material. The amounts of water indicated above are ample for one hour's fairly vigorous boiling, with the finishing volumes as indicated. If it is not at the desired height at the close, it may be made so by more water or more boiling, and either the amount of water in the second addition or the vigor of boiling can be so modified in later trials as to enable the total to be brought to the desired height approximately at the end of the hour.

"The finished product may be immediately poured or strained into a barrel or settling tank or into the spray tank. The straining is merely a safeguard to prevent any possible clogging because of imperfect materials or failure to break lumps in the sulphur. When properly made the amount of sediment left in the strainer is insignificant, being less than 1 per cent., as shown in Table I, and may be thrown away. To avoid any considerable loss of materials, however, the sediment in the strainer can be washed with part of the water used in making the next lot, simply pouring the water through the strainer into the kettle, and any lumps of sulphur discovered may be broken up and used again.

"If the straining is not done, the whole product may be put into settling tank or barrel, and the clear liquid drawn off later as required. This process, however, is likely to lose efficient liquids in the sludge, as well as the fine sludge itself, which may be of value in several ways, and is of no apparent hindrance in the spraying.

"The crust which forms on the finished material is prevented by immediately covering the solution with a layer of oil about an eighth of an inch thick, and avoiding unnecessary exposure to air in the transfer from kettle to storage tank. An ordinary paraffine oil was very satisfactory in our work, but there is no reason to believe that any other oil, not injurious to trees nor likely to take fire at boiling temperatures, may be used with equal success.

"The crust may also be prevented by immediate storage in tight, closed vessels, filling them completely. But partially filled vessels are likely to develop some crust upon continual exposure."

Lime of good quality should be used for making the home-made concentrate. Beachville lime (0.6 per cent. impurity) is of ideal quality and any lime with not more than 10 per cent. impurity would be suitable, such as Ottawa, Coboconk, Trenton, Amherstburg, Caledon, etc.

Freshly burnt lime should also be used, because air-slaked lime combines with sulphur very slowly. The latter is very good for making the ordinary home boiled wash where the amount of lime used is usually greater than the amount of sulphur, but for the manufacture of the concentrate it is wholly unsuitable.

Dry Lime-Sulphur.

This substance, which is in the form of a yellow powder, was first marketed by Sherwin-Williams in 1915, but is now made by other firms as well. It is the liquid lime-sulphur with the water, which amounts to about 70 per cent. of its weight, removed till only a small portion is left, and the whole thing assumes a dry state. The removal of the water changes somewhat the state of the sulphur, but does not materially disturb the efficiency as a remedy. A great saving is affected through the removal of the water, in containers, transportation, storage and possible leakage; and, furthermore, with the introduction of dusting, it furnishes a form of the lime-sulphur which can be applied in that way.

Samples analyzed here average about the following in composition:

Total sulphur		56.785 per cent.
As polysulphide	47.600 per cent.	
As thiosulphate	6.550 per cent.	
As other forms	2.635 per cent.	
Undetermined (Ca, H_2O and C.)		43.215 per cent.
		100.000 per cent.

Some of the sulphur, a small amount, is in the free form and thus probably largely inert. This undoubtedly is formed from the polysulphide sulphur during the removal of the water, for the percentage of the total sulphur in the form of polysulphide is 83.8 whereas in the average lime-sulphur solution it amounts to 93 or more.

Hydrated Lime as a Substitute for Stone Lime for Making Lime-Sulphur Wash.

For the manufacture of any of the lime-sulphur washes above mentioned; with the exception of the self-boiled wash, hydrated lime can replace the stone lime. It is well to know this because it is much easier to secure hydrated lime now than it is to get stone lime, the latter having been replaced largely in the building trade by the former, as a matter of convenience. When it is understood that hydrated lime is nothing but ready-slaked stone lime then the above will be clear.

In using hydrated lime, however, it must be kept in mind that one-third more, by weight, must be taken than if stone lime were used; and also that the same precautions regarding quality must be exercised, i.e., it must be made from high grade limestones such as those mentioned above, and must not have been exposed to the air for more than a short time.

Arsenicals and Lime-Sulphur Wash Combined.

In summer spraying with lime-sulphur wash it is often essential that an arsenical should be applied also, and in order to overcome the expense of a double spraying the two are mixed and put on together. Paris green, as already shown, cannot be used; and the acid arsenate of lead causes a serious loss of

dissolved sulphur (30 per cent.) unless three and a half parts of hydrated lime are used along with it. Neither neutral nor basic arsenate of lead, nor arsenate of lime, causes a serious change in the lime sulphur wash, producing a loss of only 8 per cent. or less of the dissolved sulphur.

The arsenical to use with lime-sulphur wash is any one of the arsenates of lead or calcium arsenate. *Acid* arsenate of lead is the most common form of the lead arsenical now on the market; in fact, in 1921 it was the only form which we found and in that year we analyzed all the leading brands, both powders and pastes, to be obtained on the Ontario market. In practice it has been the experience of many investigators that the addition of arsenate of lead to lime-sulphur wash increases the fungicidal power, in some cases as much as 50 per cent. But with the acid arsenate the reaction between it and the lime-sulphur is so extensive that a considerable amount of soluble arsenic is liberated with consequent danger of foliage injury. Hence the use of the hydrated lime when this form of lead arsenate is used becomes doubly essential—both to conserve the strength of the lime-sulphur wash and also to prevent foliage injury. In case the other forms of lead arsenate are used, which would probably not be often because of their scarcity, or that calcium arsenate be selected, the interaction is so small and so little soluble arsenic is produced that the mixture would not likely be dangerous. The use of hydrated lime, however, at the rate of three and a half parts, is also here recommended as a precautionary measure.

In the above combination sprays the lime-sulphur wash takes the place of the water when the arsenical is used alone. The procedure in making up the spray is therefore the same as though water were being used, the directions for which have been previously given. The quantity of hydrated lime to use, viz., three and a half parts, is for the powder form of the arsenical. If the paste form is used then this quantity becomes reduced to two parts of hydrated lime to one part of the arsenical. The agitator must be kept continually running just as when the arsenical is mixed with water, so that there shall be a uniform distribution of the poison.

Soluble Sulphur.

This material is a solid, of a greenish yellow colour, and is sold in the powder, or a small-granule, form. It is not, as its name might suggest, a form of sulphur which is soluble in water, but, on the contrary, it is a compound of sulphur, and it is the compound which is soluble.

The particular combination in which sulphur is present in this substance is as sodium sulphide, probably the tetrasulphide ($Na_2 S_4$). In this respect the sulphur is in much the same form as found in the potassium sulphide (liver of sulphur) of commerce, and will have much the same properties and uses. In the form of sodium sulphide, however, it is less expensive—sodium compounds always being cheaper than potassium compounds.

Soluble sulphur is made by heating together sulphur and sodium carbonate in a closed vessel in the proportion of about forty-eight pounds of sulphur to fifty-two pounds of sodium carbonate. The Niagara Sprayer Company of Burlington manufacture it. Samples examined here have been found to dissolve completely and easily in water to form an orange or yellow-coloured solution resembling in appearance a solution of lime-sulphur; and to contain 58 to 59 per cent. of total sulphur.

The use intended for soluble sulphur is that of a substitute for lime-sulphur. It is a solid and hence is less bulky, and thus more convenient to handle and store. It must be carefully protected from the air, however, else it will lose its

efficiency very rapidly and completely, which, of course, is also true of lime-sulphur solution, but not nearly to the same degree. Furthermore, soluble sulphur has to be used with greater caution, as it is more likely to do foliage injury.

On the whole, soluble sulphur can be used in the same way as lime-sulphur, and for the same purposes; but it must be more carefully applied than lime-sulphur, when used as a summer spray, because of its higher drastic action; in fact it should not be depended on as a summer spray unless an excess of hydrated lime is mixed with it.

Other Insecticides Recommended for Destroying the San Jose Scale.

With the spread of the scale, a large number of remedies of various kinds have been placed on the market. Among the more important of these are "Kil-o-Scale," and "Anti-Scale," or "Scalecide," "Emulsified Con-Sol" (also known as "Target Brand Emulsion,"), "Con-Sol," the "Webcide Solutions," "Zanoleum," "B. T. S.," and caustic soda and water. From the results of experiments conducted in this province and elsewhere, it does not appear that these insecticides are any more effective, if as much so, as the lime-sulphur washes, in destroying scale. Prof. C. O. Houghton states that* the so-called "soluble oils," "Kil-o-Scale" and "Emulsified Con-Sol," give satisfactory results when applied in the spring. Fall applications of "Kil-o-Scale" were satisfactory in one case, but not entirely so in another. "Scalecide" applied once as a fall spray was quite unsatisfactory so far as could be determined after a period of three months had elapsed. Applied to apple trees as a summer spray, at the rate of one part to twenty-eight parts of water, "Scalecide" gave valuable results. "Con-Scale," the "Webcide Solutions" and caustic soda in water failed to give satisfactory results in any instance. "B. T. S." gives good results, but is too expensive, and has no advantage over the lime-sulphur wash.

Crude Petroleum.

This material was first recommended for use against scale enemies by the late Dr. J. B. Smith, of the New Jersey Experimental Station. In the hands of many orchardists, however, it has been found to be decidedly damaging to many kinds of foliage, especially the more tender varieties, the apple and the pear being the only ones able to withstand its destructive power to any successful degree.

It is a very effective remedy, nevertheless, and whenever applied destroys the scale; but because of its general destroying tendencies, it cannot be recommended except for the most hardy trees.

If the crude petroleum can be emulsified, however, i.e., put into a form in which it will mix with water, it could be used with perfect safety, for it could then be diluted down to a suitable strength. Formulæ have been published for doing this, but these relate more to paraffine oil, a distillation product of crude petroleum, than to crude petroleum itself. Still, some investigators claim that they have satisfactorily emulsified crude petroleum, and we will, therefore, reproduce one of these formulæ. It consists of two parts, one for making the emulsifier and the other for making the soluble oil. (See Bull. 4, Storrs Agr. Expt. Station, Storrs, Conn.).

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*Delaware Experiment Station, Bull. No. 74, 1906.

The Emulsifier:

Carbolic Acid (liquid crude, 100 per cent.)	2	quarts.
Fish Oil (Menhaden)	2½	quarts.
Caustic potash (granulated)	1	pound.

Heat to 300 degrees Fah., remove from fire and immediately add

Kerosene	3½	quarts.
Water	5	quarts.

The heating should be conducted in an iron kettle and away from buildings, as the mixture is inflammable.

The Soluble Oil:

Emulsifier	8 parts.
Paraffine Oil	35 parts.
(or Crude Petroleum, 20 to 30 parts.)	
Rosin Oil	5 parts.
Water	1 part.
	(more if necessary.)

After the materials have been brought together in the above proportion they should be vigorously stirred with a garden hoe or some other suitable instrument. If the soluble oil has been successfully made, a few drops poured into a glass of water will give a milk-like emulsion.

For spraying, one part of the Soluble Oil is mixed with fifteen parts of water, or more or less if it is desirable to have a weaker or stronger spray, respectively.

Kerosene Emulsions.

The Kerosene Emulsions of various kinds have been recommended for destroying many forms of insect life. The kerosene is, of course, the killing agent. Dr. James Fletcher gives the following formula:*

Kerosene (coal oil)	2 gallons.
Rain water	1 gallon.
Soap	½ pound.

"Boil the soap in water till all is dissolved; then, while boiling hot, turn it into the kerosene, and churn the mixture constantly and forcibly with a syringe or force pump for five minutes, when it will be of a smooth, creamy nature. If the emulsion is perfect, it will adhere to the surface of glass without oiliness. As it cools it thickens into a jelly-like mass. This gives the stock emulsion, which must be diluted with nine times its measure of warm water before using on vegetation. The above quantity of three gallons of emulsion will make thirty gallons of wash."

Recently the *K-L* (*Kerosene Lime*) *Emulsion* has been more or less strongly recommended for destroying San José scale. It is a mixture of kerosene, hydrated lime, and water, the lime acting as a carrier or emulsifier of the kerosene. Prof. C. P. Close gives the following directions for its preparation:† "Pour the kerosene and lime into a barrel and stir together well with a paddle. Add ten to twenty gallons of water, and stir to loosen the kerosene and lime from the bot-

*Central Experimental Farm, Ottawa, Bull. 52, 1905.
†Delaware Agricultural Experiment Station, Bull. 73.

tom and sides of the barrel. Pour in water until the barrel is more than three-fourths full, and with a hoe or dasher, churn, splash and pound the K-L four or five minutes to emulsify it, then fill up the barrel with water, and spray. A long up and down stroke of a hoe or dasher is best, and if the hoe is held just right the blade goes straight down instead of glancing to the side of the barrel. *A terrific splashing can and must be made in this way.* A burlap bag or canvas should be thrown over the barrel to prevent the emulsion from splashing out. A board cover is better than burlap or canvas, and is easily made by nailing strips at the end of thin boards three feet long and boring a two-inch hole in the centre. Through this hole the hoe handle projects and the churning is more easily done than when a bag is used.

"Very small lots of two or three gallons can be emulsified by pumping the K-L back into itself through a nozzle throwing a small solid stream, but this method is not recommended for larger quantities. In fact, *the fruit grower is hereby warned not to attempt to make lots larger than two or three gallons by pumping, nor lots of any size by stirring, but always to make K-L by the most violent churning, pounding and splashing with a hoe or dasher.*

The prepared hydrates of lime on the market, or good stone lime dry slaked, are best for making K-L. Air-slaked lime is not desirable, but may be used. If the lime is fresh, four pounds per gallon of kerosene will be ample, but if old, more may be required. Use enough lime to take up all the kerosene and mix into a thin, sloppy mass. If drops of kerosene gather on the top in less than a minute, sprinkle on more lime.

Proportion of Kerosene, Lime and Water. "K-L is kerosene, lime, and water, and the proportion of each in 50* gallons of different strengths, is as follows:

"For	10%	K-L use	5 gals.	kerosene,	20 lbs.	lime,	44½ gals.	water.
"	12½	"	6¼	"	25	"	43	"
"	15	"	7½	"	30	"	41½	"
"	17½	"	8¾	"	35	"	40	"
"	20	"	10	"	40	"	38½	"
"	25	"	12½	"	50	"	34½	"
"	30	"	15	"	60	"	30½	"

"The K-L-B is kerosene, lime, and Bordeaux mixture. It is made exactly like the K-L except that the Bordeaux is used instead of water. We use the 4-4-50* Bordeaux formula. Four pounds of copper sulphate are dissolved and diluted with water to twenty-five gallons. Four pounds of stone lime are slaked and diluted with twenty-five gallons. Four or five pounds of hydrated lime or fresh dry slaked lime are usually substituted for the stone lime. The copper solution is then poured into the milk of lime and the mixture is well stirred with a paddle.

"The K-L-B-P is kerosene, lime, Bordeaux, and poison. It is made exactly like K-L-B except that poison is added to the Bordeaux. Paris green is about the most reliable poison, and one pound is used in seventy-five* gallons of Bordeaux."

Fresh lime is not conveniently obtainable in all parts of the province. Dr. Frank T. Shutt, Chemist at the Central Experimental Farm, Ottawa, has shown that flour may be used instead of lime with equally good results. With reference to the preparation, Dr. Shutt writes as follows:† "The preparation with

*Wine measure.
†*The Canadian Horticulturist*, May, 1905.

flour is most simple. The requisite amount of kerosene is placed in the vessel (pail or barrel)—which is preferably dry—and flour added in the proportion stated, viz., eight ounces to the one quart, the whole thoroughly stirred and the water added, two gallons for every quart of kerosene. This is then vigorously churned. The time necessary to churn will vary from two to four minutes, according to the quantity to be emulsified, and the emulsion is then ready for use.

"When the emulsion is required for immediate use, the quantity of flour may be further reduced. It was found that as small a quantity as two ounces would emulsify one quart of kerosene, but that on standing a few hours a perceptible layer of kerosene had separated.

"It has, further, been found that by scalding the flour before adding the kerosene a less weight is required. An excellent emulsion, which showed not the slightest separation of kerosene after one week, was prepared by scalding two ounces of flour, mixing the resulting paste with one quart of kerosene and emulsifying with two gallons of water.

"The flour emulsion is smooth, readily and easily atomized, and does not clog the nozzle. Any separation into layers (no free kerosene will appear for several days, at least) may be readily overcome or remedied by simply stirring the mixture. It is equally effective, as might be expected, as an insecticide with the lime-formed emulsion, and amongst other advantages that may be claimed for it there is no perceptible whitening of the tree or foliage; and, further, in some places it may be found cheaper and easier to make than the lime emulsion. Its use is suggested as an alternative where good lime is unobtainable and also for making the emulsion when intended for ornamental trees, shrubs, etc., where the whitening of the foliage is objectionable. The flour emulsion can be added to Bordeaux mixture, Bordeaux and Paris green, if desired."

*Soap Washes.**

"The most effective soap wash is made with whale-oil soap, one pound to from four to six gallons of water. The term whale-oil soap is merely a trade name for fish-oil soap, made with either potash or soda. The potash soaps, which are the best, because even stronger solutions remain liquid when they cool, are soft soaps. The soda soaps are hard. Of the two, the potash soaps are considered the best to use on vegetation, as well as being more convenient. Both kinds should always be dissolved in hot water.

"When bought at retail prices, these soaps cost from fifteen to twenty cents per pound, according to the locality but, if obtained in large quantities, can be got at from three to five cents per pound. Fifty-pound kegs are supplied at five cents per pound. Two well-known brands of potash soft soaps which have been much used in Canada, and have given good satisfaction, are those made by W. H. Owen, of Port Clinton, Ohio, and by Good & Co., of Philadelphia, Pa. If thought desirable, these soaps can be made at home; but it is very unpleasant and dirty work, and it is, besides, doubtful whether such good or cheap results can be secured as by buying from firms which make a special business of manufacturing soaps with only the required amount of moisture and the proper grade and amount of potash. It has been found in experiments carried on at Washington that what is required for spraying purposes is a caustic potash and fish-oil soap, made with a fairly good quality of fish-oil, and from which water has been eliminated by boiling, so that it does not exceed 25 or 30 per cent. of the weight

*Central Experimental Farm, Ottawa, Bull. No. 52. (Note.—The prices given in this quotation do not hold at the present time.)

of the soap. Soaps made with caustic soda instead of caustic potash are unsuitable for spraying purposes. Dr. J. B. Smith (New Jersey Experiment Station), in his Circular No. 5, "Whale-oil Soap and Its Uses," says: "Whale-oil, or fish-oil, soap is one of the most reliable materials for use against plant-lice, and generally against sucking insects which can be killed by contact insecticides. It kills by clogging the spiracles, or breathing pores, of the insects, and also to some extent by its corrosive action. The advantages of fish-oil over ordinary laundry soap lie in the greater penetrating power, in the fact that it remains liquid when cold, at much greater strengths, and that fish-oil itself seems to be more fatal to insect life than other animal fats. A good soap can be made as follows:

Concentrated potash lye	3½	pounds.
Water	7½	gallons.
Fish-oil	1	gallon.

Dissolve the lye in water, boil, and to the boiling solution add the fish-oil; continue to boil for two hours, and then allow to cool. Any grade of fish-oil will answer.

"Whale-oil soap may be applied in the strength of one pound in four gallons of water for brown or black plant-lice, and one pound in six gallons for green plant-lice; warm water should always be used when dissolving it.

"Soaps of all kinds are very useful in adding adhesiveness to liquid mixtures when it is necessary to apply these to such vegetation as cabbages, turnips, peas, etc., which have their leaves covered with a waxy secretion which prevents water from lying upon them. Any kind of soap will answer for this purpose, and it may be remembered that one quart of soft soap is about equal to one pound of hard soap."

Another method for making home-made fish-oil soap is given by Van Slyke and Urner, and is as follows:*

Caustic soda	6	pounds.
Water	1½	gallons.
Fish-oil	22	pounds.

"The caustic soda is completely dissolved in the given amount of water and the fish-oil is added gradually under constant and vigorous stirring. The combination occurs readily at ordinary summer temperatures and the operation is soon completed. The mixing may be done in any receptacle sufficiently large to contain the whole amount of material. It would probably not be desirable to attempt to make more than twenty to forty pounds at a time, since the difficulty of thoroughly stirring a larger mass would tend to make a complete combination less sure, thus rendering liable the presence of too much free alkali. *Complete and thorough stirring is essential to success.* Caustic soda should be handled with precaution, since in concentrated form it easily injures the skin."

The authors show that when caustic soda can be got for four and a half cents per pound and the fish-oil at twenty-nine cents per gallon, the material for forty pounds of soap, costs $1.14, or 2.85 cents per pound.

The above formula will produce about forty pounds of soap.

Hydrocyanic Acid Gas, HCN.

This insecticide is used largely in the fumigation of nursery stock. It is also used for destroying scales on orchard trees and for ridding mills, stores, and

*New York Experiment Station, Bull. No. 257, 1904.

elevators of grain pests and rodents. The applicability of it was first demonstrated in California, where it was found useful in combating the cushiony scale affecting citrus trees, but it has since found a very extended use against other insect enemies.

The gas is not bought as such, but is prepared at the time of use from a substance known as potassium cyanide (KCN). The cyanide is a white solid, and when treated with sulphuric acid ($H_2 SO_4$) is decomposed or broken up and the gas liberated as:

$$KCN + H_2 SO_4 = HKSO_4 + HCN$$

Pot. cyanide. Sulphuric acid. Pot. acid sulphate. (Hydrocyanic acid gas.)

The gas at low temperature condenses to a liquid and is then, when dissolved in water to a 10% strength; called *prussic acid.* The liquid boils at 26.5° C., and thus is easily changed into the gas again. Being quite light, the gas rapidly diffuses and penetrates to every little nook and corner of the fumigating enclosure. For this reason it is very effective, and, when supplied in sufficient quantity, leaves nothing undone.

Fumigation of trees is best done while in the dormant state; if trees in foliage are treated, night should be chosen as the time for action, since the rays of the sun have a very damaging effect on leaves for some time after they have been surrounded by the gas.

As the gas is *extremely poisonous*, great care should be taken that it be not inhaled; and before a building or tent is entered after the operation, a thorough airing should be given.

For generating the gas, an open glazed vessel is used, an ordinary crock serving the purpose admirably. The water is first placed in the vessel, the sulphuric acid is then added, and last, the potassium cyanide is dropped in and the door quickly closed. All ventilators, cracks and openings should previously be tightly closed to prevent any leakage or waste of gas. The amounts of the different materials employed are as follows:

Potassium cyanide (98 per cent.)	1 ounce.
Sulphuric acid (1.83 specific gravity)	1 fluid ounce.
Water	3 fluid ounces.

Enough will be supplied by these quantities to fill 150 cubic feet of confined space. If there are 300 cubic feet of space, then twice the quantities given will have to be employed; if 375, then two and a half times; and so on up. The factor to be used can always be found by dividing the cubical contents by 150. For fumigating greenhouses where such tender plants as the tomato are present the following amounts of materials will be found ample to produce enough gas to exterminate the white fly and yet leave the foliage unharmed:

Potassium cyanide (98 per cent. pure)	¼ oz.
Sulphuric acid (1.83 sp. gr.)	½ fl. oz.
Water	1 fl. oz.

for each 1,000 cubic feet of space.

Within the last few years, beginning especially during the war period, sodium cyanide has largely, if not altogether, substituted the potassium compound for the generation of the hydrocyanic acid gas. It is every bit as satisfactory, if pure, and also cheaper. In using this source of the gas it must be remembered, however, that the same weight of sodium cyanide will produce one-third more gas than potassium cyanide, i.e., the weight of potassium cyanide that will produce one hundred parts of gas that same weight of sodium cyanide

will produce about one hundred and thirty-three parts of gas. For this reason sodium cyanide is often referred to as being 133 per cent. pure. Wherever a formula calls for potassium cyanide, therefore, and one is using the sodium cyanide as a substitute it must be kept in mind that only three-quarters as much of the sodium cyanide must be weighed out; or to the contrary, if sodium cyanide is called for in the formula and potassium cyanide is to be used then one must take one-third more of the latter in order to get the proper amount of gas.

Since this gas is one of the most efficient fumigants for destroying meal worms, flour moths, and other insects which inhabit mills, granaries, flour storages, etc., and because we often get enquiries for procedure in fumigating such enclosures, we include here full directions for carrying on: For each 1,000 cubic feet of space use:

Sodium cyanide	1	pound.
Acid mixture*—Sulphuric acid (sp. gr. 1.83)	1½	pints.
Water	3	pints.

Place the water in a stone jar or some other receptacle of like nature, pour in the acid and then drop in the cyanide, the latter being preferably wrapped loosely in paper, such as a manilla sack. Of course, before the cyanide is dropped into the acid mixture everything must be in readiness and the operator must *immediately* leave the room as soon as the cyanide is dropped in. The building must be as nearly air-tight as possible and to provide for ventilation after the fumigation is completed, two opposite windows or doors should be arranged so that they can be opened from the outside. Place danger signs on all sides of the building and have all other windows and doors securely fastened; and for double security one or two efficient and responsible guards should be placed at the vulnerable spots. The cyanide should be broken into small lumps, none of which should be larger than a hen's egg and it should be handled with leather gloves and out in the open air where the operator may avoid inhaling the dust. Care should be taken to avoid any particles flying into the eyes or mouth, indeed it is well to protect the eyes with goggles. If the room is large it is a good plan to generate the gas in three or four different receptacles distributed throughout the room. If such is done, always begin dropping the cyanide at the jar farthest from the final exit and work quickly towards the door. Drop the cyanide into the vessel nearest the door last, immediately leaving the room at this time and locking up. The gas is extremely poisonous and if the fumes are inhaled they are almost sure to prove fatal.

The building or room should be allowed to fumigate for at least eighteen hours and, if time will permit, from twenty-four to thirty-six hours. After fumigation is completed, open the windows and doors from without for ventilation and do not enter the place until it has been aired for at least two hours.

Since most insects are more or less inactive at a temperature below 50° F., it is necessary to choose a warm day to get the highest beneficial effects of the gas. Therefore choose a time when the temperature of the enclosure to be fumigated is likely to be about 70° F. or above. Everything should be done in the way of preparation of the place during the day so that the charge can be set off in the evening before dark.

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*When mixing strong sulphuric with water as is called for in this formula, always pour the acid into the water and not the water into the acid. The mixing can be done right in the earthenware crock used. Avoid spilling on the clothes or person.

After any operation is completed where hydrocyanic acid gas has been generated, the liquid left in the jars should be collected and disposed of down the sewer or in a pit. Avoid spilling any of the contents of the jars on the floor or person, and clean the jars thoroughly before putting away, disposing of all washings in the same way as above.

Carbon Bisulphide, CS_2.

As the formula indicates, this compound is made up of carbon and sulphur, one atom of the former and two of the latter. In the pure form it is a clear liquid with a pleasant odour, but when impure it is somewhat coloured and possesses a highly disagreeable smell. It boils at 114°.8 F., and thus volatilizes or changes to a vapour or gas very readily at ordinary temperatures. This gas ignites at a temperature of 248° F.

The vapours are very poisonous, and thus are very valuable in dealing with grain weevils, and the pea bug; and also for overcoming subterranean workers. Its use was first discovered in France, where it was and is employed against the grape phylloxera. The wine districts there were saved from complete annihilation by its introduction.

Since the vapour is 2.63 times heavier than air, it tends to work downward very rapidly, and will thus penetrate to some depth in the soil. In dealing with grain pests the liquid is placed in shallow dishes on top of the pile and then as the evaporation goes on, the vapour will work downward and penetrate the whole bulk.

Dosage: (1) For grain weevils, use one pint (one and a half pounds) for every 1,000 cubic feet of space. Place in shallow pans on top of the grain, using at least one pan in every twenty-five square feet of surface. Thus a bin of grain twenty-five feet long, by five feet wide, by eight feet deep, would require one pint to be distributed in five pans. Larger quantities would not be harmful and would be more effective; the fluid is cheap, therefore employ an overdose rather than an insufficient quantity.

(2) For pea bugs use one pint for every 100 bushels of peas.*

(3) For subterranean workers (root maggots, etc.,) inject small quantities into the soil around the base of the infested plant, two or three teaspoonfuls in a place.

As with hydrocyanic acid gas, all openings should be well sealed to prevent escape and waste. Inhalation should also be avoided as much as possible, although small quantities breathed in will produce no harm except in case of a weak heart. Fresh air is the cure, and when one begins to feel a dizziness, it is wise to seek at once the open atmosphere. Before entering a room where it has been used, thorough ventilation should be given.

Precaution:—As one volume of carbon bisulphide vapour mixed with 14.3 volumes of air forms a highly *inflammable* and *explosive* mixture, *never allow a light or even a spark*, or a lighted pipe or cigar to be brought near it.

Carbolic Acid, Phenol $C_6 H_5 OH$.

This substance is an oxygen derivative of benzene, one of the members of the aromatic series of the carbon compounds. It has a permanent but characteristic and pleasant odour, which seems to be quite distasteful to many insects. In the undiluted form this acid is very active, and will burn and blister the flesh and cause much pain, but in the diluted form, as one part to forty or fifty parts of

*See Ontario Agricultural College Bulletin, No. 126, pp. 26-27.

water, it makes an important disinfectant that is extensively used in medicine. In the form of an emulsion with soap and water it is very useful in destroying the eggs and young maggots which infest onions, radishes, and similar garden crops.

The emulsion is made thus:

Carbolic acid	1 pint.
Hard soap	1 pound.
Water	1 gallon.

Dissolve the soap in the boiling water, and while boiling add the acid and continue the boiling for a few minutes, stirring thoroughly. Put the emulsion away in a tightly closed vessel and label "*Stock Solution of Carbolic Acid—Poison.*" Before using, dilute one part of the stock solution with fifty parts of water.

Carbolic acid is also used in the form of what is known as "Carbolized Plaster," in which case the acid is mixed with land plaster (gypsum), road dust, air-slaked lime or some other diluting medium, and is then sprinkled or dusted on in the dry state.

Carbolic acid	1 pint.
Diluent (land plaster, etc.)	50 pounds.

This mixture is said to be very effective against flea beetles, cucumber beetles, etc.

Tobacco.

A strong decoction that is very obnoxious to insects and at the same time poisonous (nicotine) can be made from tobacco (stocks, refuse leaves, sweepings, etc.), by steeping in water for a prolonged period. This could be made a very valuable source of an insecticide by those living in a tobacco district, or near a tobacco factory.

A good way to use the strong extract, although it can be sprayed as it is, after it is diluted with water to about the colour of strong tea, is as follows:

Hard soap	1 pound.
Water	8-10 gallons.
Strong tobacco extract	1 gallon.

Dissolve the soap in boiling water, add the decoction and then make up to eight to ten gallons.

Nicotine Sulphate.

There are a number of commercial tobacco preparations on the market which have largely superseded the home-made decoctions. These have the nicotine in the form of the sulphate and many of them are quite highly concentrated. Some of these latter carry as much as 40 per cent. of nicotine and come on the market under trade names such as "Black Leaf 40," "Sulphate of Nicotine 40 per cent.," etc. These remedies are very valuable for controlling soft bodied insects such as aphids, and can be applied in strengths for good control which are not injurious to foliage.

These strong solutions are usually applied at the rate of about half a pint per forty gallons of water, or one to one and a half teaspoonfuls per gallon.

Since the tobacco remedies act as paralyzants, the vapour of the nicotine entering the body of the insect and paralyzing its nerves, it follows that the nicotine sulphate, which is non-volatile, would not be of the highest efficiency. It

is therefore a good plan to add soap, hydrated lime, or some other alkaline material to aid in the liberation of free nicotine, which *is* volatile. A good formula for a soap wash to which to add the nicotine sulphate is:

Soap	2 to 4 pounds.
Water	50 gallons.

or about one ounce of soap per gallon of water. Soap also increases the spreading power.

Nicotine dusts are also now quite prominent, they being just as efficient or more so than the sprays, and can be applied faster with less cost. In the dusts such carriers as kaolin, talc, kieselguhr, gypsum, sulphur, carbonate of lime, hydrated lime, etc., are used. Some of these are merely adsorbents and do not make the nicotine volatile enough to be efficient such as kaolin, gypsum and sulphur; whereas hydrated lime and carbonate of calcium are not only adsorbents for the nicotine solution, but also make the nicotine volatile and efficient. The best dusts, therefore, are those which contain an alkaline adsorbent but in this case the dust has to be kept in tightly sealed containers and if possible the containers kept full, else much of the nicotine vapour would be lost and the dust greatly weakened.

The nicotine sulphate and tobacco solutions lend themselves well to the making of combination sprays, they being compatible with almost all of the standard spray materials.

Pyrethrum (Insect Powder, Buhach).

This powder is also called Dalmatian Insect Powder and Persian Insect Powder. It is also, like hellebore, obtained from plants, being the pulverized flowers of the botanical genus Pyrethrum. Value as an insecticide is due to the presence in it of an oil which is exceedingly poisonous to most insects, but practically harmless to human beings and the higher animals. It can be used with impunity, therefore, and on account of this fact is of special value.

The oil which imparts the killing power (largely by contact with the body of the insect) is very easily disseminated into the surrounding atmosphere and thus lost. For this reason these powders must be fresh and have been kept in tightly sealed receptacles, else they will be ineffective.

Application can be made in a number of ways:

1. *In solution:* One ounce to three gallons of water.
2. *Dry:* Apply while dew is on in the morning or after a rain.
3. *Dry, with dilution:* Mix with some flour or other light powder to any extent desired. Apply as 2.
4. *In fumigation:* Dust over live coals; for dealing with mosquitoes and flies.

Paradichlorbenzene, $C_6 H_4 Cl_2$ (p).*

This is a substance which is recommended for controlling the peach borer. It is a white crystalline powder, insoluble in water and which vaporizes slowly at ordinary temperatures, the gas or vapour being heavier then air. It is non-poisonous to man unless eaten, whereas its vapour is quite poisonous to insects. The vapour will also injure tender roots and young and succulent growth of plants, but has no marked injurious effect on old growth.

In applying, weeds, grass, leaves, stones, sticks, etc., are removed from the base of the tree without disturbing the soil more than necessary and any gum

*New Jersey Agri. Expt. Sta., Cir. No. 126.

excretions about borings are scraped off. Three-quarters to one ounce of the powder, which should be dry and fine enough to pass a ten-mesh sieve, are then evenly distributed in a continuous circular band about two inches from the trunk of the tree. Over this is then placed four to six shovels of dirt free from grass, weeds, sticks, etc., and compacted, all without disturbing the crystals. Best results are obtained if the crystals are placed on a level with or above the highest boring, but this is not necessary if the dirt is piled high enough over the crystals and larvæ within the tree.

The application should be made when the temperature of the soil is 60° F. or higher, a temperature of 55° to 60° F. requiring about 14 to 21 days to kill the larvæ, and a temperature of 70° F. requiring only 10 to 14 days. It is also not to be recommended on trees younger than six years without exercising care. Best results are obtained when the soil is dry, a wet soil requiring longer exposure. When the treatment is over the soil that has been piled around the tree should be pulled away.

The application is best made in the fall after the eggs have been hatched, as the larvæ are then young and easy to kill.

Insecticides of Miscellaneous Application.

Many of the above contact insecticides are also toxic in action and will act to a certain degree as food poisons. This is true particularly of pyrethrum and the tobacco preparations. However, for this purpose it is far better to rely upon the more active poisons, the arsenicals.

The food poisons will also exert some contact efficiency in that they are capable of stopping up the breathing pores of insects which crawl over or through them, either when in the wet state or dry state. It is far better to depend upon the regular contact remedies, nevertheless, because it is the corrosive action of a contact remedy which really makes it efficient, or the fact that it can be breathed in as a paralyzing, suffocating or poisonous gas. None of these properties are possessed to any extent by any of the regular food poisons.

FUNGICIDES

It has long been known that chemical compounds are useful in combating fungous diseases. As early as 1807 it was found in France that copper sulphate would prevent the germination of the spores of corn smut, but this discovery, one of a very important nature, was not appreciated or made known till a much later date. Sulphur was long used in the same country, but was not nearly so energetic as desired. No advances were made, however, till 1882, when the value of the compounds of copper became known. Since then great strides have been made in improved methods.

As indicated above, copper is a very important ingredient in fungicides. Nearly all the leading remedies contain it in some form or other; and so widely are its compounds used that we have come to term the combinations in which it occurs as "The Copper-Salt Fungicides."

Copper-Salt Fungicides.

Bordeaux Mixture.

This substance derives its name from the city of Bordeaux, in France, as it was in the vineyard district surrounding this place that it was first found useful. Therefore the name gives no indication as to what ingredients are present.

The source of the copper in this fungicide is copper sulphate, or what is commonly known as "bluestone." Now copper sulphate is an "acid salt," i.e., it is a salt which shows an acid reaction and will turn blue litmus paper red. This property of bluestone is due to the fact that it is a compound formed by the combination of a weak alkali ($Cu(OH)_2$) with a very strong acid ($H_2 SO_4$), the outcome being that of a salt in which the acid property predominates. Being acid, copper sulphate therefore cannot be applied to foliage, because it exerts a burning or destroying influence. Like white arsenic, it must be changed to some other form, a form which will not be injurious. Bluestone can be applied to foliage in a diluted form without doing harm, but in such a highly dilute form that it is not very effective as a fungicide.

The material used in making Bordeaux to overcome the acid property just mentioned is calcium hydroxide (slaked lime, hydrated lime, milk of lime). When calcium hydroxide is added to the bluestone, dissolved in water, the following theoretical reaction takes place:

$$\underset{\text{Copper sulphate.}}{CuSO_4} + \underset{\text{Calcium hydroxide.}}{Ca(OH)_2} = \underset{\text{Copper hydrate.}}{Cu(OH)_2} + \underset{\text{Calcium sulphate.}}{CaSO_4}^{*}$$

Provided enough lime has been used to act on all the copper sulphate, the latter will now all be present as copper hydrate, a precipitate or sediment of a beautiful sky-blue colour, and which is practically insoluble in water. In this form, as a solid suspended in water, it is sprayed onto the foliage without fear of doing any injury.

Being in a solid form, copper hydrate, or Bordeaux, as it is called, is inert and will not act on the fungus. It must be changed to some form on the leaf which will be soluble in water. This change is brought about by carbon dioxide of the air and by that contained in dew and rain, or even by that which comes from the leaf itself.

How to make the Bordeaux Mixture. The first thing to do in the manufacture of the Bordeaux mixture is to decide on some recommended formula. The formula which has long been advocated in Ontario is known as the 4-4-40 formula. It is as follows:

$CuSO_4$ (crystallized copper sulphate)	4 pounds.
CaO (quick lime)	4 pounds.
Water	40 gallons.

With good lime it only needs about one pound to act on all the copper; the excess given, three pounds, covers all danger which might arise from the use of a poor article. A large excess of lime is a disadvantage,—it causes the Bordeaux mixture to exert a low fungicidal action, it is apt to cause the machinery to clog and to cause an uneven application, and the particles of lime offering more resistance to rain, will cause the mixture to be more rapidly washed from the trees. It may be an advantage, however, in a very wet season, by causing the

*In reality a much more complex reaction than the above occurs whereby a basic sulphate of copper is formed, the exact make up of which is governed by the proportion of copper sulphate and calcium hydrate used.

Bordeaux to retain its efficiency longer and by allowing less injury to be done to foliage. Orchardists are inclined to use a less proportion of lime, and the following formula is recommended:

$CuSO_4$ (crystallized copper sulphate)	6 pounds.
CaO (quick lime)	4 pounds.
Water	40 gallons.

As both copper sulphate and lime dissolve and slake, respectively, much quicker in hot water than cold, it is better to use heated water in order to save time. The very best lime obtainable is used, and if freshly burned, all the better. In slaking do not use an excess of water, but just enough to keep the lime moist. When the action is completed enough water is added to make a thin whitewash and then the whole is strained through coarse sacking to remove any lumps which would clog the nozzle of the spray pump. This done, enough water is added to make the volume up to one-half of what the final mixture will amount to. The copper sulphate solution is diluted to the same extent. The two are now mixed, the operation being best performed by two men, each with a bucket, one handling the lime and the other the copper sulphate. They are poured into the spray tank, two bucketfuls at a time, until the whole is brought together. In this way a precipitate is obtained which will remain in suspension with only occasional agitation. If mixing is done before dilution, a very coarse precipitate is formed which settles rapidly to the bottom of the spray tank and requires almost constant stirring.

If large quantities of spray mixture are going to be used, it is an excellent plan to make up "stock" solutions of the copper and lime. This can be done by dissolving, say, one pound of copper sulphate in each gallon of water and making up a barrel full of it. Each gallon of the solution taken then represents one pound of the bluestone. The salt can be conveniently dissolved by filling the barrel with water and then suspending it therein, enclosed in a canvas sack. The lime can be handled in the same way, being sure, of course, that the contents of the barrel are thoroughly stirred up before dipping out any portion. Keep the barrels covered when not in use.

However, with the income of the ready slaked form of lime, or hydrated lime as it is called, a corresponding change in the above procedure for making the Bordeaux has resulted. In the first place it is not necessary to slake the lime and hence that part of the work is dispensed with and in the second place, the amount of lime to take is increased from four pounds to five and one-third pounds or about one-third more.

Furthermore, with spraying operations now on a much larger scale, and with more powerful spraying machinery available it has become customary to dissolve the copper sulphate, put it into the spray tank, dilute it to full volume, and then to throw in the hydrated lime. This is then mixed with the agitator, the latter's efficiency and power being depended upon to put the Bordeaux into the proper physical condition for efficient spraying.

Also, as time goes on, formulæ change according to changing conditions and enlarged experience. The tendency at present is to use a much larger proportion of lime to copper sulphate and the most recent recommendation is:

Copper sulphate	3 pounds.
Hydrated lime	8–9 pounds.
Water	40 gallons.

Precautions to be Used in Making. Before Bordeaux mixture is sprayed, it is absolutely necessary that all copper should be in the form of the sky-blue

precipitate, i.e., enough lime must be used to act on all the bluestone. Formulæ advocated by the experiment stations always contain enough lime to precipitate all the copper, but it may sometimes happen that such a very poor quality is used that there will be some of the sulphate left unchanged. There are several simple ways by which one can tell when enough lime is present. Those who are very familiar with the reaction which occurs can tell by the colour of the precipitate, it having a greenish tinge when an insufficiency of lime is present instead of the deep sky-blue colour. However, those who are not familiar with the process must use more decided tests. Three simple ones can be employed, as follows:

1. Take some of the clear solution which is left on top when the sediment settles and place in a white saucer. Add a few drops of a solution of potassium ferrocyanide to it. If a reddish brown precipitate or colouration appears, more lime is needed.

2. Take a portion of the clear fluid as before, and blow the breath gently over the surface. If a thin white pellicle or covering forms over the top, enough lime has been added.

3. Take a bright piece of steel, such as a knife blade, and hold it in the mixture for a minute or more. If it becomes coated with copper, more lime is required.

Test number one is the most reliable, and is the one recommended. The test solution, potassium ferrocyanide, can easily be made by anyone. One ounce of the salt is purchased at the drug store and this amount dissolved in ½ pint of clean, pure rain water. It is then ready to use.

In handling copper solutions use only wooden, brass or copper vessels; all other receptacles would be corroded and destroyed by them; besides, the fungicide itself would be injured.

Copper compounds are *poisonous*, and therefore should not be left lying around where children or animals can get at them.

Combined with an Insecticide. Bordeaux mixture is quite often combined with Paris green to impart to it an insecticidal value. In this case the mixture takes the place of water for holding the green in suspension. Other recommended arsenicals can be used for this also, such as calcium arsenate, lead arsenate and calcium arsenite. If soluble compounds of arsenic are used, such as sodium arsenite or white arsenic*, it would be necessary to slightly increase the amount of lime used in making the original Bordeaux mixture. The use of soluble arsenicals, however, is not to be recommended.

Bordeaux Paste.

This substance is merely the ordinary `ordeaux mixture from which the excess of moisture has been removed. It, as a fungicide, is made on the same principle as lead arsenate paste. By the addition of water a spray of any desired strength can be made from it.

A sample which we analyzed contained 6.42 per cent. of copper oxide (CuO), an amount which is equal to 20.23 per cent. crystallized copper sulphate or bluestone ($CuSO_4$, $5H_2O$), and 19.85 per cent. of lime (CaO). Therefore, one pound of this paste would make two gallons of spray equal in strength to ordinary Bordeaux mixture. Its flocculent condition has been destroyed to a great extent, however, and it settles about ten times as rapidly in the spray tank as does freshly prepared Bordeaux.

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*Agricultural Gazette, Jan. 1920, pp. 10-12.

Bordeaux Powder.

This material is the ordinary Bordeaux mixture reduced to the dry form by the removal of nearly all the water, and corresponds in principle to the powder arsenate of lead. By the addition of water a spray of any desired strength can be obtained.

It contains about 12½ per cent. of copper oxide or enough copper, in other words, so that one pound to four gallons of water would make a spray approximately equivalent in strength to ordinary Bordeaux mixture. It is particularly designed for dusting operations.

Soda Bordeaux.

This fungicide is made from copper sulphate just as the ordinary Bordeaux mixture. It differs, however, in that caustic soda is used to neutralize the acid property of the bluestone instead of lime; and that the final mixture contains sodium sulphate instead of calcium sulphate (gypsum). The resulting form of the copper, copper hydrate, is exactly the same, and exerts the same fungicidal power. The reaction which occurs may be represented by the following equation:

$$CuSO_4 + 2NaOH = Cu(OH)_2 + Na_2SO_4.$$

Caustic Soda. Copper hydrate. Sodium sulphate.

The main point in connection with this mixture is that caustic soda is an extremely active alkali, and any amount of it added over and above that required to combine with all the copper will destroy foliage. Therefore, in making Soda Bordeaux, it is *important to add just the exact quantity of the soda required to change all the bluestone to copper hydrate.* This is done by adding the soda solution slowly to the copper solution, mixing thoroughly after each addition, and testing for the neutral point with litmus paper. The moment the litmus paper takes on a faintly blue tinge is the time to stop adding. The copper is then all in the form of a sediment, and any more alkali added will be left in the free state.

The following tentative formula can be given:

Soda	2 pounds.
Copper sulphate	6 pounds.
Lime	5 ounces.
Water	40 gallons.

In making, add three-quarters of the soda solution at once, mix thoroughly and then add the rest gradually, mixing and testing until the proper quantity is present. It may not require the whole amount recommended, and it may require more depending upon the quality of the soda. When the alkaline value of a sample of soda is once ascertained, then one can proceed with much more rapidity. The small amount of lime is added to make the mixture decidedly alkaline, and, therefore, safe, and to cause the precipitate to remain blue instead of changing to dark brown or black, which it does after standing some time where an excess of soda is used.

Caustic soda can be bought retail or in drums of one hundred pounds, from or through any chemist, while Gillett's lye, which is familiar to everyone, is a convenient form of soda for use in making Soda Bordeaux.

Soda Bordeaux has an advantage over the ordinary Bordeaux in that it is just as good a fungicide, and, at the same time, is made without the labour of slaking and preparing of lime. There are disadvantages, however:

1. Great care is necessary in the addition of the caustic soda. Any added in

excess is dangerous to foliage; an excess of lime is not harmful, although not advisable.

2. Unless exactly neutral, the addition of an arsenical to Soda Bordeaux to impart to it an insecticidal power, is dangerous. Any free alkali will act upon the arsenic compound and form sodium arsenite, which, being soluble, will scorch foliage.

This last difficulty has been experienced by some orchardists, and for this reason they may be prone to condemn Soda Bordeaux. However, if care enough be exercised, no harm can result from this source.

Soda Bordeaux can also be made by using washing soda in place of sodium hydrate whereby a basic copper carbonate is formed as the active principle of the spray. This method of preparation overcomes some of the objectionable features of the previous Soda Bordeaux in that washing soda is a comparatively mild alkali and any excess would not be so harmful as is an excess of sodium hydrate. The Bordeaux made from "Blighty" is probably of this kind, and has given good satisfaction in England.

Woburn Bordeaux.

The Woburn Fruit Experiment Station* (England), have a method for making Bordeaux mixture which they claim gives a far superior spray to that obtained by the methods just mentioned. In their method lime-water is used in place of milk of lime, and also much less copper sulphate is used.

The method is as follows:

	Formula.	
	A.	B.
Copper sulphate (crystallized)...	2 ounces.	1 ounce.
Lime water.....	13½ pints.	6¾ pints.
Water (soft) to make to.....	9½ gallons.	9½ gallons.

Dissolve the copper sulphate in a little water and then pour the lime-water into it and mix thoroughly. After it stands and settles for a time take a little of the clear liquid from on top, put into a white saucer and add to it a few drops of potassium ferrocyanide solution. If a brown or red colour appears a little more lime-water must be added, and the operation of stirring, settling and testing repeated.

To Make Lime Water. Take two or three pounds of good stone lime, slake it in a little water and then add this to 120 gallons of soft water. (If hard water is used, use more lime.) Stir the lime and water up two or three times at intervals of several hours, and leave it to settle till the solution becomes quite clear. Run this clear liquid off and keep it covered from the air. The clear liquid is the lime water.

Formula A gives a spray corresponding in strength with that of ordinary Bordeaux; Formula B gives a spray one-half as strong, and is the strength now recommended for spraying.

Copper Carbonate.

This valuable fungicide can be readily and easily made at home at much less cost than for what it can be bought on the market. The following method of making is recommended: A barrel is partly filled with water and twenty-five

*Eighth and Eleventh Reports of the Woburn Experimental Fruit Farm.

pounds of copper sulphate are dissolved in it, and into this is poured a solution of thirty pounds of sodium carbonate (common washing soda). The copper is thrown down as a pale green precipitate of "basic" copper carbonate. This precipitate rapidly settles to the bottom, and after a time the clear solution above can be siphoned off. The barrel is filled with water again, the precipitate stirred up and allowed to settle, and the clear solution again drawn off. This washing removes the greater part of the impurities (sodium sulphate) and leaves behind about twelve pounds of basic copper carbonate. This can be removed from the barrel and dried in the air, after which it is ready for use.

The following quantities can be used for spraying:

Copper carbonate	1 pound.
Water	40 gallons.

Ammoniacal Copper Carbonate.

This spray is made from basic copper carbonate the preparation of which has just been outlined under "copper carbonate." When ammonia is added to this material, it dissolves to form a deep blue solution, and this solution diluted with the requisite quantity of water forms the well-known spraying compound.

This fungicide is of use in that it can be applied to trees when the fruit is well advanced in the stage of maturity without causing any disfigurement, such as would result from the employment of Bordeaux. This last material leaves a coating if sprayed just a short time before the fruit is picked, which does not enhance marketing qualities, and which, further, might cause poisoning.

Following are the quantities of material to use:

Copper carbonate	5 ounces.
Ammonia (spr. gr. 26° Baumé)	3 pints.
Water	45 gallons.

Eau Celeste.

The name of this material indicates that it was originated in France, and it was there in 1885 it first came into use. It has decided action against fungi, but it exerts quite a caustic action on foliage, and for this reason cannot be much recommended. It is made in the following way:

Copper sulphate	1 pound.
Hot water	2 gallons.

When the crystals are dissolved and the liquid has cooled, add:

Ammonia (sp. gr. 22° Baumé)	1½ pints.
Water, to make	25 gallons.

When the ammonia is first added a precipitation occurs, but on the addition of the excess this precipitate disappears and a deep blue solution results.

Copper Sulphate, Bluestone, $CuSO_4.5H_2O$.

As was stated when dealing with Bordeaux mixture, this compound can be used to combat fungous diseases on plants, but if used in a solution concentrated enough to be of material benefit would destroy the foliage. Nevertheless, for dormant wood it can be used quite freely, and is recommended in the following strength:

Water	15–25 gallons.
Copper sulphate	1 pound.

In dealing with grain smuts, however, where the strength of the solution is not so necessarily guarded, this substance has been found to be decidedly beneficial. The Experimental Department of this College has done some extended work in dealing with smutted grain, and report the following results in connection with bluestone treatment with oats:*

(*a*)	Copper sulphate	1 pound.
	Water	25 gallons.
(*b*)	Copper sulphate	1 pound.
	Water	1 gallon.

In solution (*a*) smut affected grain was immersed for a period of twelve hours; and in (*b*) for a period of five minutes. After treatment the grain was dried and sown in test plots, along with a check plot of some left untreated. An average of three years trial gave these data:

	Percentage of smutted heads.
(*a*) Treatment	0.2
(*b*) Treatment	1.1
Untreated	7.0

These results show that bluestone has a very decided action in checking smut, and this is especially marked with treatment (*a*).

For making copper sulphate solutions for smut treatment, or for producing the various Bordeaux preparations, a special finely crushed form of the substance is now put on the market to take the place of the large lump form. This pulverized form dissolves quickly and a great deal of time is saved by using it if one happens to be in a hurry. Otherwise it has no advantage over the lump form.

Also a special dehydrated or anhydrous form of copper sulphate is now available. This substance is a white, non-crystalline powder and is useful for dusting. It is specially prepared for mixing with hydrated lime in the proper proportion for making Bordeaux, and then either dusted on or mixed with the proper quantity of water and sprayed on. In this last case, i.e., when made into a spray, it turns into ordinary Bordeaux mixture.

Fungicides Containing No Copper.

Lime-sulphur.

The lime-sulphur wash is a very active fungicide and is displacing the copper salt fungicides to a great extent. It has to be applied in a very dilute condition. The method of diluting is outlined under the previous discussion of the wash on a preceding page (page 19); the extent of the dilution will vary, but can be found in any good spray calendar.

Formaldehyde, CH_2O.

Formaldehyde is a gas, which under the influence of cold condenses to a clear mobile liquid that boils at —21° C. If this liquid be mixed with water until it forms 40 per cent. of the volume, we have a commercial article known as "formalin," and which is used and is valuable as a fungicide. It is especially useful as a treatment for grain smuts and potato scab.

*Ont. Agri. College Bulletin 140, pp. 14-15.

Using the following strengths of formalin and method of treatment:

(*a*)	Formalin	½ pint.
	Water	21 gallons.

(Immersing for twenty minutes),

(*b*)	Formalin	½ pint.
	Water	5 gallons.

(sprinkling and stirring till thoroughly moistened), the Department of Agronomy (Bull. 140, pp. 14-15) obtained the following results with oats the figures giving the percentages of smutted heads in the crop obtained from sowing the treated grain:

(*a*)	.0 per cent.
(*b*)	.0 per cent.
Untreated	7.0 per cent.

These results show that both treatments with formalin entirely destroy the smut spores adhering to seed grain. These formulæ will also serve for the treatment of wheat.

Corrosive Sublimate, $HgCl_2$.

This chemical, also known as mercuric chloride, is a white crystalline solid. One hundred parts of cold water will dissolve only seven parts of the compound thus it is not very soluble. The rate and extent of solubility can be increased by using hot water, one hundred parts of the latter being able to dissolve fifty-four parts of the substance. Its water solutions are very corrosive on metallic vessels, such as iron, tin, zinc, aluminium, etc., and hence its name "corrosive sublimate," and for this reason solutions of it cannot be made or stored in such receptacles; wooden vessels only should be used.

It is an *extremely poisonous* compound and should be handled and used with the greatest care. As a spray, on foliage, it is not used because of its corrosive action, although it would form a deadly poison to insects and fungi; but as a treatment for root maggots such as those of the onion, cabbage, cauliflower, radish, it is exceptionally satisfactory when used at the rate of one ounce to ten gallons of water and sprayed onto the ground just at the base of the stem. It controls the maggots by contact action.

The solutions of this chemical are also very effective fungicides and germicides, and are used for treating potatoes for scab, and for disinfecting pruning tools when cutting out diseased limbs in cases of fire blight, etc. For these purposes the following formula is very satisfactory:

Corrosive sublimate	1 ounce.
Water	7–8 gallons.

In making the solution a wooden vessel is used and the salt is tied in a muslin sack and suspended in the water; or the salt is dumped into the water and stirred with a wooden paddle until dissolved. If the water is warmed solution is effected much more quickly.

Potatoes treated for scab by sprinkling or by immersion in the solution, are poisonous and should not be used as food.

Liver of Sulphur, Potassium Sulphide.

This substance is a compound of the elements potassium and sulphur, and its solution possesses considerable value as a treatment for certain fungous

diseases, such as the gooseberry mildew; but it is not nearly so energetic as are the copper compounds. It is used to some extent in treating grains for smut, for which the following quantities are recommended:

Potassium sulphide	1 pound.
Water	24 gallons.

This solution should be used in a wooden vessel, and must be applied soon after making, since on standing in contact with air the sulphide becomes oxidized to the sulphate and thus loses in strength.

COMBINATION SPRAYS AND DUSTS.

It very often happens that a plant is attacked by more than one enemy at the same time so that more than one kind of combative treatment or material has necessarily to be utilized. For instance, it frequently occurs that a fungous disease and some insect, either biting or sucking, attack together. In such cases it is desirable that a combined application of a fungicide and insecticide should be given if such a combination is possible for in so doing the labour of putting each one on separately is dispensed with. In other cases still, it sometimes happens that a biting and sucking insect are preying on a plant at the same time, and if a food poison and a contact poison can be mixed together and applied in one operation a big item of expense, namely, labour, is proportionately curtailed.

Unfortunately, it is not possible to combine indiscriminately the various substances which are available; but nevertheless many combinations are possible and entirely satisfactory in every way and the practice of using combined treatments is now quite well developed.

The need and desirability of adopting combined treatments was early recognized and began to be carried out a number of years ago; and manufacturers of spray materials have, from time to time, put out desirable combinations. Such a combination is illustrated by "Pyrox," a mixture of Bordeaux paste and lead arsenate paste, i.e., a combined fungicide and food poison. It would evidently fulfil collectively the same functions as its two ingredients would each accomplish singly, and its use has been attended with very satisfactory results.

Following is the analysis of samples of this remedy which we have examined from time to time:

Water	63.05	per cent.
Lead oxide (PbO)	17.88	"
Copper oxide (CuO)	4.58	"
Arsenic oxide (As_2O_5)	7.55	"
Sulphur trioxide (SO_3)	0.46	"
Calcium oxide (CaO)	1.23	"
Undetermined material	5.25	"
	100.00	"

It will be seen that pyrox contains arsenic equivalent to 30 per cent. of neutral lead arsenate; and enough copper so that one pound of the paste would produce about one gallon of spray equal in strength to ordinary Bordeaux.

However, pyrox is only one example among many others. Among others might be mentioned the following:

(*a*) *Sprayide*—a combination of arsenate of lime and Bordeaux mixture in a dry powdered form, a combined food poison and fungicide suitable for either dusting or spraying.

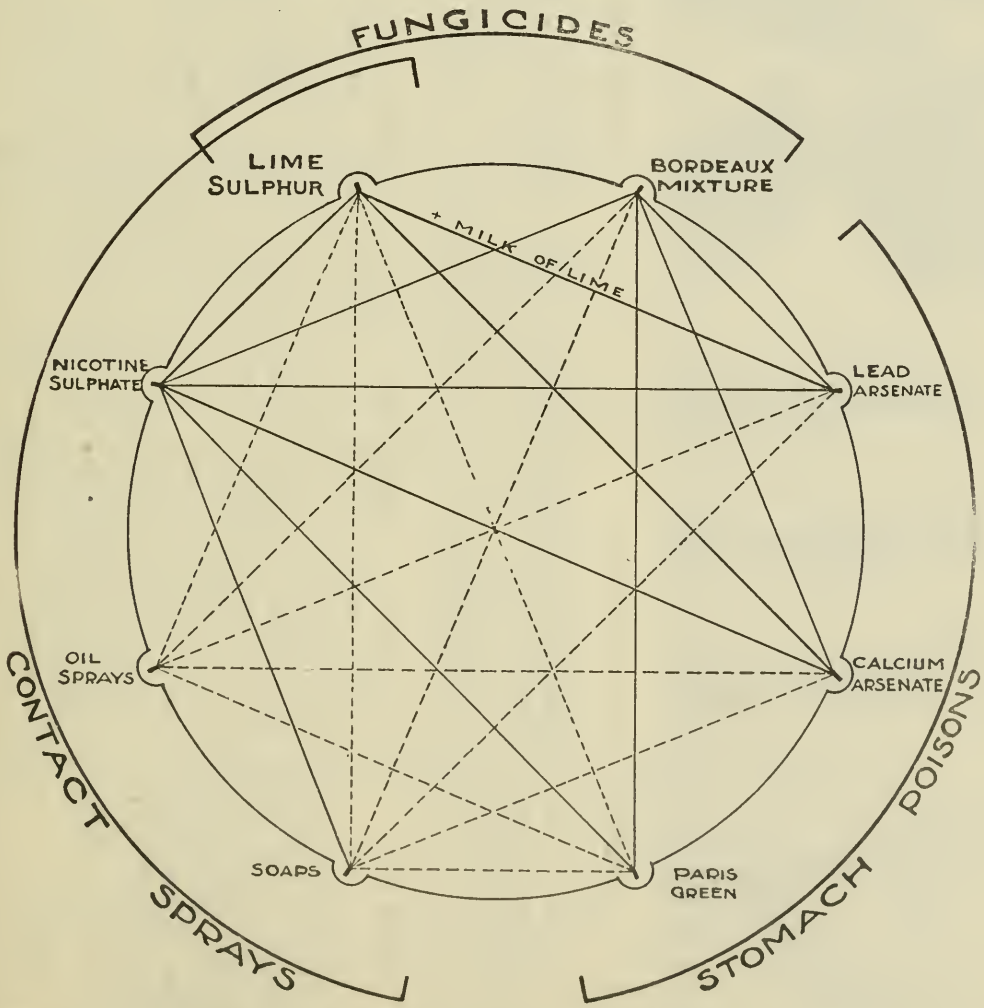
(*b*) J —C *Bordo-Arsenate*—a combination of Bordeaux and calcium arsenate, the same as the above, and has the same uses.

(*c*) *Bug-o-cide*—a blend of Paris green and other arsenicals in order to get the quick and vigorous action of the former combined with the slower and prolonged action of the latter.

The above examples do not nearly exhaust the list of prepared combinations, but will serve to illustrate the principle. A whole host of combinations are possible and many of them can be, and are, made by the user himself, e.g., lime-sulphur and lead arsenate, Bordeaux mixture and Paris green, nicotine sulphate and soap wash, Paris green and lead arsenate, and so on.

The main things to keep in mind in making combination spray materials are (1) What the mixture is to be used for so as to make the proper choice of suitable ingredients; and (2) Not to mix any ingredients which will harm the effectiveness of each other or produce products which will harm the plant on which it is placed. In other words only efficient and compatible things are to be mixed and made into combination spray substances.

As a guide to those things which can be mixed to form combination sprays or dusts the following diagram is appended as adapted from Bull. No. 201, Mass. Agr. Expt. Sta. (See pp. 42-43 for discussion.)



Guide Chart for Mixing Spray Materials.
————Desirable combinations - - - - - - - - Undesirable combinations

Stages for first application.

Stage for second application.

Stage for third application.

SPRAY CALENDAR FOR FRUIT TREES AND BUSH FRUITS

PLANTS AND PESTS.	FIRST APPLICATION.	SECOND APPLICATION.	THIRD APPLICATION.	REMARKS.
APPLE. Scab or black spot, canker, leaf spot, codling moth and other biting insects, scale insects, blister mites and aphids. (Consult bulletins 187, 194, 198, 219, 250 and 257.)	If scales or blister mites are present use LS1, before the buds burst, preferably just before; if no scales or blister mites present postpone until buds have burst and use LS2, or B1. If dust is used wait until the leaflets are nearly the size of the old five-cent piece.	When blossom buds are showing pink and are ready to burst use LS2, plus 3 or 4 lbs. hydrated lime and either A1 or A2; or use B1 and A1 or A2. If dust is used wait until the blossoms are beginning to burst.	When nearly all the blossoms have fallen use LS3, plus 3 or 4 lbs. hydrated lime and either A1 or A2 or may use dust. Don't delay this spray.	For scab spray with LS4, or B2 or dust about 10 days after the 3rd application if June is wet, also an intermediate one between the 2nd and 3rd with LS3, *without any poison*, if the interval, owing to cool, damp weather, threatens to be long. For side worms use A1 with water 3 weeks after third application. Spraying with B2 or LS4 or dusting about August 20th is an insurance against *sooty fungus* and *late scab*. If *Aphids* are annually troublesome, delay 1st application till buds begin to burst, then add nicotine-sulphate 40 per cent. to LS1, and cover every bud. For *Apple Maggot* spray with A1 first about July 5 and again about August 1. Spray whole orchard. For *Cankers* cut out diseased bark. For *Blight* on young trees keep suckers rubbed off trunk and main branches and cut out promptly any diseased branches or twigs well below the diseased bark. Always disinfect both cuts and tools with corrosive sublimate (1 to 1,000 or 1 to 500).

PLANTS AND PESTS.	FIRST APPLICATION.	SECOND APPLICATION.	THIRD APPLICATION.	REMARKS.
PEAR. Scab or cracking, blight, codling moth, other biting insects, scale insects, blister mite, psylla and slug. (Consult bulletins 176, 187, 219, 250 and 257.)	If scales or blister mites present use LS1 before the buds burst, but if psylla is troublesome too postpone until just before the blossoms open. Varieties subject to scab should be sprayed at both above times.	Just before the blossoms open if psylla not present use B1 and A1 or A2, or LS3 with 3 or 4 lbs. hydrated lime and A1 or A2. If psylla present use LS1 as stated under first application.	Soon after the blossoms have all fallen use B1 and A1, or A2, or use LS3 and 3 or 4 lbs. hydrated lime with either A1 or A2. If psylla present add to either of the above nicotine sulphate 40%.	Pears subject to *scab* should always receive a 4th application 10 days later than 3rd with same mixture. For *blight* cut out carefully in winter all blighted branches and twigs, cutting several inches below the diseased part. Also remove and burn trees too severely blighted to save. Throughout growing season watch for and remove promptly in the same way all blighted twigs or branches. Disinfect at once tools and all cuts with corrosive sublimate (1 to 1,000 or 1 to 500). Arsenate of lead applied about June 15th will kill *slugs on leaves* (3 lbs. paste or 1½ lbs. powder to 40 gals.). For side-worms spray with A1, three or four weeks after the blossoms fall.
PLUM AND CHERRY Black knot, brown rot, leaf blight or shot-hole fungus, curculio, slug, aphids and cherry fruit-flies. (Consult bulletins 219, 226, 227, 230, 250 and 257.)	Just before the buds burst use LS1. For aphids on sweet cherries add nicotine sulphate 40%.	As soon as the remnants of the blossoms are nearly all off use B1, with A1, or LS3, with A1. B1 is preferable to LS3, on sour cherries. Either of the common dusts is also used on cherries.	As soon as early varieties begin to color use either B1 or LS3, with A1. B1 is preferable to LS3 on sour cherries. Either of the common dusts is also used.	For *rot* keep fruit well covered in moist weather with LS3 or B1 or sulphur dust, and spray with LS4 or dust with sulphur without any poison just before picking. For *cherry fruit-flies* (the cause of the *little white headless maggots* in cherries) use A1 on all cherry trees jusr as Early Richmonds are getting a reddish blush, and again on only Montmorency and late varieties about 10 or 12 days later. Cut out and burn all *black knots* in winter and whenever seen in summer. For *slugs* on *leaves* see under Pear above. *Good pruning* with plenty of sunlight and air helps against *Rot.*
PEACH. Leaf-curl, scab or black spot, yellows, little peach, curculio, borer, San José scale, shot-hole borer. (Consult bulletins 241, 250 and 257.)	Spray in fall when leaves have fallen or in spring before the buds begin to swell. (All must be done before any sign of bursting of buds.) Use LS1. This is usually the only spraying peach trees receive.	Soon after the fruit is set use A1, if curculio is troublesome; otherwise omit.	About one month after the fruit is set dust with sulphur, or use LS5, if brown rot or black spot is troublesome; otherwise omit.	If *brown rot* is likely to be troublesome use LS5 again about one month before fruit ripens, or dust with sulphur, two weeks before picking. Destroy mummied fruit in autumn. Remove at once and burn any tree attacked by *yellows* or *little peach.* Dig out *borers* at base of tree with knife in May and again in October. For *shot-hole borer* cut down and burn before April all dead or dying trees or branches, and leave no brush heaps near orchard.

PLANTS AND PESTS.	FIRST APPLICATION.	SECOND APPLICATION.	THIRD APPLICATION.	REMARKS.
GRAPES. Black rot, powdery mildew, downy mildew, anthracnose, flea-beetle, leaf hopper (Consult bulletin (237.)	When 3rd leaf is appearing use B1.	Just after the fruit has set use B1.		Spray again whenever wet weather threatens. It should always be done *before*, not after rain. *At very first sign of powdery mildew* dust with sulphur or spray with LS5. For *flea beetles* use 3 or 4 lbs. arsenate of lead to 40 gals. water whenever they appear. For *leaf-hoppers* use nicotine sulphate 40%, applied very carefully to under-surface of leaves about the 10th of July to destroy nymphs. Clean cultivation is important and destruction of old mummied grapes and prunings.
CURRANT AND GOOSEBERRY. Mildew, leaf-spot, currant worm, aphids, red spider and San José scale. (Consult bulletin 222.)	Shortly before or as buds burst use LS1. For San José Scale prune and spray heavily. If aphids are present add nicotine sulphate 40%.	Just before blossoms appear, use B1, with A1 or A2. LS2 is not so good as B1.	Just after fruit is formed use B1, as in previous application. May omit poison on black currants.	For *worms* when fruit is ripening, use hellebore, 1 oz. to 1 gal. water. To prevent leaf drop make an extra application of Bordeaux two weeks after third on black currants or immediately after fruit is off on red and white currants.
RASPBERRY AND BLACKBERRY. Anthracnose, red rust, crown gall. (Consult bulletin 210.)	Before growth begins use B1. Omit if not troubled by anthracnose.	When shoots are 6 or 8 inches high use B1. Omit if no anthracnose.	If caterpillars are attacking the leaves use 1 oz. hellebore to 1 gal. water; or spray with lead arsenate, 1½ lbs. to 40 gals. of water.	If *anthracnose* is very severe, set out new plantation of healthy shoots. If disease begins, cut out old canes as soon as fruit is picked, also badly attacked new ones, and burn. For *red rust* remove and burn plants at once. No other remedy. For *crown gall* set out plants in fresh soil, rejecting any plant with a gall on root or crown.
STRAWBERRY. Leaf-spot and white grub. (Consult bulletin 210.)	For *leaf spot* set out only healthy plants with no sign of disease. First year spray with B1 before blossoms open, and keep plants covered with mixture throughout the season. Second year spray before blossoming with B1 and again soon after picking. Plow down at once after second crop. To prevent injury from white grubs do not plant on land broken up from old meadow or pasture for at least three years after breaking. It is a good plan to plant after clover. For weevils dust heavily with 1 lb. arsenate of lead and 5 lbs. finely ground sulphur as soon as weevils appear and again about a week later.			

NOTE.—LS1 = Lime-sulphur 1.030 to 1.035 specific gravity. 1.030 = 1 gal. commercial to about 9 gals. water. 1.035 = 1 gal. commercial to 7 gals. water. The stronger mixture is for San José Scale.

☛ LS2 = Lime-sulphur 1.008 to 1.009 sp. gr. = 1 gal. commercial to about 35 gals. water.
LS3 = Lime-sulphur 1.007 to 1.008 sp. gr. = 1 gal. commercial to about 40 gals. water.
LS4 = Lime-sulphur 1.006 sp. gr. = 1 gal. commercial to 50 gals. water.
LS5 = Self boiled lime-sulphur. For method of making see below.
B1 = Bordeaux mixture 3, 6, 40 formula. See below.
B2 = Bordeaux mixture 2, 4, 40 formula. See below.
A1 = Arsenate of lead, either 3 lbs. paste or 1½ lbs. powder to 40 gals. liquid.
A2 = Arsenate of lime, 1 lb. powder to 40 gals. liquid. See below.

FORMULAE FOR INSECTICIDES

INSECTICIDES FOR BITING AND LAPPING INSECTS.

1. ARSENATE OF LEAD.

Use 3 lbs. of the paste or 1½ lbs. of the powder to 40 gals. of lime-sulphur, or of Bordeaux mixture or of water. With lime-sulphur it is wise to add 3 or 4 lbs. of hydrated lime before putting in the poison.

2. ARSENATE OF LIME (Calcium arsenate).

Use 1 lb. if in powder form to 40 gals. of Bordeaux mixture. Double the amount if in paste form. If this poison is used with lime sulphur add 3 or 4 lbs. of hydrated or freshly slaked lime to every 40 gals. of the liquid to prevent burning.

3. HELLEBORE. (Not good if left exposed to air.)

1 oz. to 1 gal. water.

INSECTICIDES FOR SUCKING INSECTS ONLY.

1. LIME-SULPHUR.

For Scale insects, Blister Mites and Red Spider.

2. TOBACCO EXTRACTS.

For Aphids, Leaf-Hoppers, Psyllas, etc.

(*a*) Black-Leaf 40, strength to use is indicated on the cans.

(*b*) Nicotine-Sulphate 40%. Strength is indicated on the cans. (Practically same as Black-Leaf 40).

(*c*) Home-Made Extract. Soak 1 lb. tobacco refuse in 1 gal. water for 24 hrs. with occasional stirring, or steep 1 lb. in 1 gal. water for 1 hr. Make up for water that evaporates. Use at once without dilution: spoils in a few days if not used.

3. KEROSENE EMULSION.

Kerosene (Coal Oil).....2 gals.
Rain Water.....1 gal.
Soap.....½ or 1 lb.

Dissolve the soap in water by slicing and boiling; take from fire, and while hot pour in kerosene and churn vigorously for five minutes, or better pour into spray tank and pump through the nozzle back upon itself for 5 minutes. For use dilute with 9 parts of water, so that the above 3 gals. of stock emulsion will make 30 gals. of spray mixture.

4. WHALE OIL SOAP.

For brown or black aphids, 1 lb. in 4 gals. rain water. For green aphids, thrip and leaf-hopper, 1 lb. in 6 gals. rain water.

FORMULAE FOR FUNGICIDES

I.—BORDEAUX MIXTURE.

Bluestone (Copper Sulphate)....3 lbs.
Hydrated Lime, 9 lbs. or fresh stone lime.....8 lbs.
Water.....40 gals.

A weaker Bordeaux may be made by using 2 lbs. bluestone, 6 lbs. hydrated lime and 40 gals. water.

Hydrated lime is much the more convenient form to use, as it can easily be secured and stored and does not require slaking.

Hydrated lime if left exposed to the air becomes worthless, so keep it in tightly fastened paper bags in a dry place.

To Prepare Bordeaux Mixture.—Dissolve the bluestone; then nearly fill the tank with water; add the proper amount of dissolved bluestone; start the engine to agitate the liquid; add the hydrated lime or slaked stone lime, and agitate the mixture for about 5 minutes. If a hand outfit is used agitate by pumping the liquid back upon itself for 5 minutes.

Note—The easiest way to dissolve bluestone in the crystal or lump form is to place 40 lbs. of it in a bag and suspend this over a barrel containing 40 gals. of water, in such a way that the bottom of the bag sinks only 3 or 4 inches below the surface of the water. Leave over night and in the morning all will be dissolved. 1 gal. of the liquid will now contain 1 lb. bluestone. Small quantities can be rapidly dissolved in boiling water by stirring. Granulated bluestone dissolves very readily and is usually placed in the desired amount upon a burlap screen on the hopper or inlet of the tank and dissolved by the water being poured over it as the tank is filled.

II.—Lime-Sulphur. The commercial product is commonly used. For strength see above under LS1, LS2, LS3 and LS4. For directions for making the *home-made lime-sulphur* consult bulletin 198, which also contains full directions for testing the mixture and for the use of the hydrometer.

III.—Soluble Sulphur. This is a powdered form of combined soda and sulphur. Applied at the strength of 12½ to 14 lbs. to 40 gals. water before the buds burst it will control San José Scale.

IV.—Dust. There are to-day two kinds of dust, 1st 90% finely ground sulphur and 10% arsenate of lead powder, and 2nd, finely powdered bluestone combined with hydrated lime and arsenate of lime powder. These can also be secured without the poison. Dusting is satisfactory as a supplement to spraying in large orchards, but we do not feel safe in recommending it as a substitute for the liquid spray.

V.—Self-Boiled Lime Sulphur (chiefly for use on peach foliage to prevent rot.)

Fresh stone lime..... 8 lbs.
Sulphur (flour or flowers).. 8 lbs.
Water.....40 gals.

Best prepared in quantities of 24 lbs. at a time, to get sufficient heat. Place 24 lbs. lime in a half barrel, add enough cold water to start it slaking well and to keep the sulphur off the bottom. Dust the 24 lbs. sulphur over the lime, having first worked the sulphur through a screen to break lumps, then add whatever further amount of water is necessary to complete the slaking. Stir well with a hoe to prevent the lime caking on the bottom. As soon as the slaking is over, add enough cold water to cool the whole mass and prevent further combination. Strain into spray tank. Keep well agitated while spraying.

VI.—DISINFECTANTS (for pruning tools and for wounds on trees):—

1. Corrosive Sublimate, 1 part to 1,000 by weight, = 1 tablet to 1 pint of water. Apply with a swab on end of a stick or piece of sponge in mouth of a bottle.

   Caution.—Corrosive sublimate is a deadly poison to man or beast if taken internally. It will also corrode iron or metal, so use in a glass or wooden vessel and be sure to wash these out very thoroughly when through using them.

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Common Edible and Poisonous

Mushrooms of Ontario

By R. E. STONE, Ph.D., Associate Professor of Botany.

INTRODUCTION.

In recent years considerable interest in mushrooms has developed. This interest was greatly stimulated during the Great War by the food conservation propaganda. Numerous articles in newspapers and magazines called attention to the large amount of food that was going to waste through lack of appreciation of the wild mushrooms. The interest thus aroused seems to be quite general, as hundreds of inquiries concerning mushrooms are received from all parts of the Province.

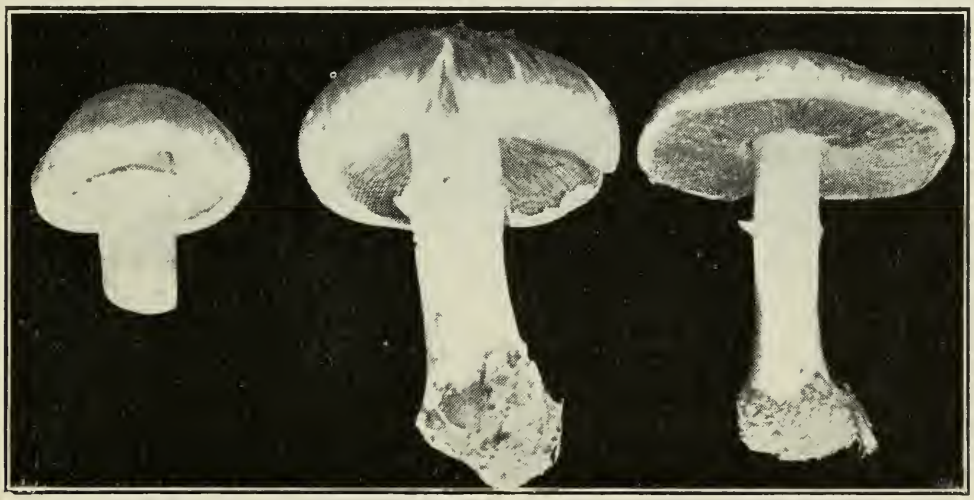

FIG. 1.—Common or Cultivated Mushroom. Edible. Natural Size (Original).

Many persons at present are able to go into the fields and woods and gather mushrooms and not only experience the pleasure of hunting for them, but add a wholesome variation to their diet. Many would follow their example if they were able to distinguish poisonous fungi from the edible species. There is no simple test which can be applied that will determine the wholesomeness of mushrooms.

What Mushrooms Are.

All of us are acquainted with green plants such as trees, flowers and grass, and when we think of plants it is these which we have in mind. But there are other plants which are not green and which do not produce flowers or seeds, and are often more or less inconspicuous. They are associated with the spoiling and decay of food, wood, etc. When a piece of bread is left in a warm, moist place, it soon becomes covered with blue or black mould. This mould is a plant belonging to a class of plants known as fungi. In like manner wood, straw, or leaves if kept moist, are soon covered with a growth of fungi which may form large, woody or fleshy masses.

The term mushroom is used to mean these large, woody or fleshy fungi. They may be seen growing on the trunks of trees, on stumps, or fallen logs, coming out of the leaf mould on the forest floor, or in the grass in yards, lawns, fields and pastures or along the roadside. The plants may look like round balls, or shelves or brackets, or caps supported on slender stems, or branched and coral-like. In colour they may vary from white through pink, red, yellow, blue, brown to nearly black, but never grass green.

It is seldom that we see the entire plant. The part we usually see is the fruiting body, which compares to the whole plant much as an apple to an apple tree. The feeding part, called the spawn or mycelium, consists of fine white or coloured threads running all through the material upon which the plant is growing.

Parts of a Mushroom.

In order to understand the structure of the mushroom let us examine the common cultivated kind. (Fig. 1.)

What we commonly call a "mushroom" is the fruit body of a fungus growing in decaying organic matter such as old leaves, straw or rotting stable refuse. This fruit body consists of a fleshy cap or pileus two or three inches in diameter supported on a stalk or stipe which comes up out of the ground. This stalk is three or four inches long and one-half inch thick and quite solid. On the under side of the cap are the gills or lamellae. These are thin plates standing on edge and radiating out from the stalk like the spokes of a wheel. In a young fruit, called a button, these gills are protected by a curtain or veil which stretches from the stalk to the edge of the cap. As the cap expands the veil is torn apart, a little of it remaining as a ragged fringe on the edge of the cap but most of it remaining as a ring or annulus on the stalk or stipe.

In some of the wild mushrooms the stalk may be absent, the cap being attached by one side to logs or stumps on which the fungus is growing. In a few forms, especially in some poisonous plants, there is at the base of the stalk a large, shaggy or scaly bulb or a distinct cup called the poison cup or volva from which the stipe arises.

How Mushrooms Grow.

Mushrooms are flowerless plants without leaf green (chlorophyll). Since they have no flowers they have no seed, but reproduce by means of minute bodies called spores, which are formed on the gills. As they have no leaf green (chlorophyll), they cannot make their own food as the green plants do, so they depend upon the food made by other plants or upon animals. Some obtain their food from living plants and animals; they are robbers (parasites). Others

live on the dead decaying remains of other plants or animals, and are scavengers (saprophytes).

When the "mushroom" or fruit body is ripe the spores are shed and are blown away by the wind. If the spores settle in a favourable place, warm, moist and with food present, they sprout or germinate. Finally they form many fine white or coloured threads which spread all through the material which can furnish food. These fine threads are the spawn or mycelium. As the spawn grows it gives off substances called enzymes, which digest the wood, old leaves, straw or manure in which the fungus is growing. As the material is digested it is absorbed by the spawn and used as food. The substance upon which the fungus is feeding gradually breaks down, that is it decays and disappears.

The spawn may grow a long time before it fruits. Even in the cultivated mushroom, when conditions for growth are made as favourable as possible, it is usually six weeks from the time the spawn is planted until the "mushrooms" appear.

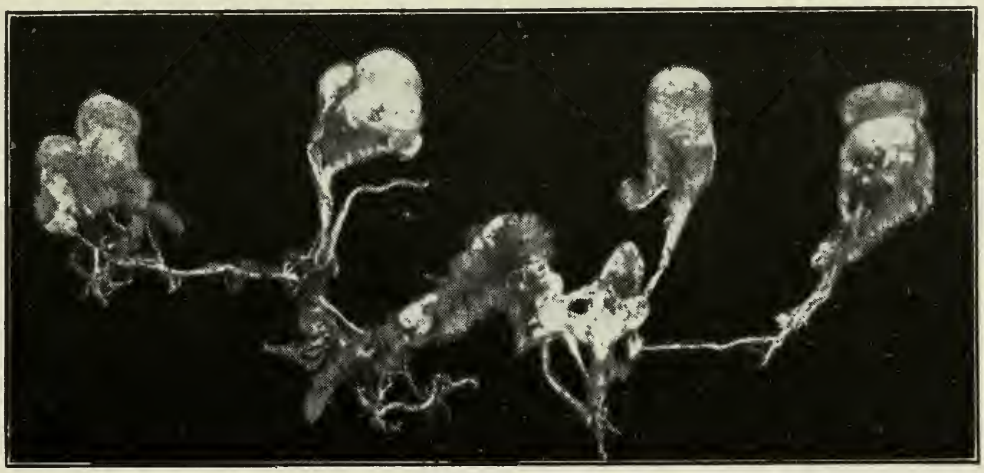

Fig. 2.—Button Stage of Common or Cultivated Mushroom. Natural Size (Original).

When the spawn has gathered sufficient food it then begins to form the fruit bodies or "mushrooms." (See Fig. 2.) These at first are tiny white balls, smaller than a pin head. They grow rapidly in size, and when they are as large as a small marble one can recognize the main parts. In the top will be the cap, with the gills underneath, protected by the veil, while the lower part is the stalk or stipe. When the parts have all been formed the "mushroom" enlarges rapidly and pushes up out of the ground. Very frequently the stalk elongates so rapidly when the fruit body is nearly grown that the cap may be pushed up out of the ground during the night, so that some people have thought that these mushrooms grew in a night.

When and Where to Look for Mushrooms.

Mushrooms may be found from the time the ground thaws out in the spring until it freezes up in the fall. They are most plentiful after prolonged wet weather or after warm rains when the days are warm and the nights fairly cool and damp. It is best to look for them on cool, dewy mornings, a day or two after warm heavy rains. Autumn is the time when mushrooms are most abundant but they may be found from the time the frost goes out of the ground in spring until it freezes hard again in late autumn or early winter.

They grow any place where there is plenty of decaying vegetable or animal material which is not too much disturbed by cultivation. Some kinds grow in

rich, well manured lawns, others in pastures, several varieties along the roadside. Some delicious kinds grow in barnyards. Many grow best in the woods, some in the leaf mold on the forest floor, some on stumps, some on fallen logs and a few on standing trees. City garbage dumps produce abundant crops of mushrooms, especially the Shaggy Mane and Ink Caps. Any golfer will tell you that they are only too abundant on golf courses.

Gathering Wild Mushrooms.

When one is gathering wild mushrooms a basket is the best receptacle for carrying them, as different compartments may be made for holding the various kinds, and thus keep from crushing and spoiling the more tender ones.

When collecting mushrooms for the table they should never be pulled up or broken off. In the deadly poisonous mushrooms the most marked characteristic, the poison cup or volva, is deeply buried in the soil. If the plant is pulled up or broken off the poison cup is lost, and it is impossible to distinguish the poisonous kinds from certain edible ones. After a mushroom has been carefully dug up and examined and the collector is certain that it is edible, the lower part of the stalk may be cut off to get rid of the dirt. It is often very difficult to determine mushrooms from the young or button stage, so that unless buttons are accompanied by mature plants they should generally be avoided. In case of doubt the fungus should be discarded or the complete specimen shown to one who knows mushrooms very thoroughly.

Rules to be Observed in Gathering Wild Mushrooms.

It is impossible to give a simple rule or test for detecting poisonous mushrooms. Care must be taken to observe the characteristics of each mushroom gathered.

The following rules, if carefully followed, will enable one to avoid the poisonous forms:

(1) Avoid fungi when in the button or unexpanded stage; also those in which the flesh has begun to decay, even if only slightly and those that contain larvae or worm holes.
(2) Avoid all fungi which have stalks with a swollen base surrounded by a sac-like or scaly envelope, especially if the gills are white.
(3) Avoid fungi having a milky juice, unless the milk is reddish.
(4) Avoid fungi in which the cap is thin and very brittle, and in which the gills are nearly all of equal length, especially if the cap is bright coloured.
(5) Avoid all tube-bearing fungi in which the flesh changes colour when cut or broken, or where the mouths of the tubes are reddish, and in the case of other tube-bearing fungi experiment with caution.
(6) Avoid all mushrooms which have a bitter or unpleasant taste or unpleasant odour.
(7) Avoid all mushrooms which are distinctly acrid or biting.
(8) In case of doubt discard the plant.

Mushrooms which May be Gathered.

The foregoing rules are given as a warning against comparatively few plants; the edible mushrooms are more numerous, and those that may be gathered are as follows:

All the puff balls and coral fungi; any of the hedge hog or spiny fungi and the morels; also any mushroom whose gills become brown; mushrooms having reddish or orange milk; all mushrooms that melt down into an inkly liquid when mature; many mushrooms with white gills, but care must be taken to be absolutely certain that they have no poison cup or volva.

Food Value of Mushrooms.

The food value of mushrooms is not as great as that of many of our staple foods such as meat, wheat-flour, or beans, but it is about equivalent to that of our fresh vegetables. In addition, they give distinct and pleasing flavours to other food, and by furnishing the needed variety to our diet they become valuable as food accessories also. Further, if one knows wild mushrooms this extra food and luxury may be had at the expense of a few minutes' walk on a cool morning, or a trip to the woods or parks on a holiday.

During the past year numerous articles have appeared in newspapers and elsewhere advocating the use of wild mushrooms for food. From these articles one might be led to suppose that they had a very high food value, *i.e.*, "twice that of fresh vegetables or half that of lean meat." A careful examination of the chemical analyses of many species shows that mushrooms vary considerably in composition but in general are 90 per cent. water and 10 per cent. solid matter. In fact their composition resembles very closely that of turnips or cabbage. They are not "animal-like" in their nature as one might suppose from the popular statement that mushrooms are "vegetable beefsteak". A glance at the following table will show the food value of some common kinds compared with some of our staple foods:

NUTRITIVE VALUE OF TEN POUNDS OF SEVERAL FOODS.*

	Proteids.	Fats.	Carbo-hydrates.	Calories.
a. Beef (round)	1.87	.88	.....	7,200
Beans (dried)	2.23	.18	5.91	15,900
b. Cabbage	.18	.03	.49	1,400
Potatoes	.18	.01	1.53	3,250
Flour (roller process)	1.13	.11	7.46	16,450
c. Shaggy Mane (*Coprinus comatus*)	.04	.025	.434	987
Oyster Agaric (*Pleurotus ostreatus*)	.051	.042	.828	1,811
Morel (*Morchella esculenta*)	.094	.05	.306	955
Common Cultivated Mushroom (*Agaricus campestris*)	.18	.03	.46	1,316
Oysters	.61	.14	.33	2,350

*Atkinson, Geo. F.—Mushrooms, Edible, Poisonous, Etc.

In the past the claim for the high food value of mushrooms has been based on the relatively large amount of nitrogen present, as this was taken as an indication of the presence of proportionally large amount of proteids, the characteristic substance in lean meat. Careful analysis of the mushroom substance has shown that a large part of this nitrogen containing substance is insoluble in gastric juice, *i.e.*, is indigestible. The reason for this seems to be that some of the nitrogen enters into the formation of fungous cellulose which has the

composition $C_6 H_{11} O_5 N H_2$, and resembles horn, hair and chitin, and consequently cannot be considered of any value as food.

To Know Wild Mushrooms.

There are in Ontario at least 150 kinds of fleshy fungi, which are large enough to attract the attention of a person collecting mushrooms for table use. However, not all of these can be used, as some of them are poisonous. Four of these are deadly poisonous and a few are reputed mildly poisonous and a few, which occur only occasionally, have unknown properties.

When one is gathering mushrooms one of the first questions he is asked is, "How do you tell mushrooms from toad stools?" This question implies that the inquirer thinks of mushrooms as edible and "toad stools" as poisonous. This question may be answered by saying that mushrooms and toad stools are the same. There is no sharp line of distinction, and no simple test which can be applied to distinguish the edible from poisonous forms. The so-called peeling test is useless, as one of our most poisonous forms peels as readily as the cultivated mushroom. The blackening of silver was at one time supposed to show that mushrooms were poisonous, but this test is of no value, as the blackening of silver only indicates the presence of sulphur or its compounds, and has no relation to poisons present. Some people say, "Collect only those mushrooms which grow in fields and pastures." Unfortunately, our deadly poisonous mushrooms, although generally growing in the woods, sometimes grow in lawns and pastures. On the other hand, if one does not gather mushrooms in the woods and parks many of the very best kinds will be missed.

The only way to be sure that mushrooms gathered are wholesome is to learn to know the mushrooms from their characters the same as we learn to know other plants. When one goes out to gather berries he must distinguish between nightshade and strawberries or between elderberries and spikenard. He comes to know the edible ones and to recognize those that are not edible, and leaves the latter alone. In the same manner one must learn to distinguish the mushrooms. This may be done by going out with someone who is familiar with mushrooms and has gathered them for use many times, or one may learn to know mushrooms by gathering the different kinds and carefully comparing them with descriptions and pictures. This method is, perhaps, the one which many will have to use.

In order that more people may learn to know some mushrooms and thus utilize part of the food that is being wasted, the most common edible kinds and also the poisonous ones that are likely to be found in Ontario are described and photographs of them are shown. A key to the mushrooms has also been added in order to make the identification of them as easy as possible.

There is still another way to learn mushrooms. The Department of Botany of this College will be very glad to identify any mushrooms sent in for this purpose. In order to have them identified they should be prepared as follows:

Carefully dig up the mushrooms so that all the fruit body, including the very base of the stalk, is present. Wrap in dry paper, taking care not to crush the specimens. A note should be attached which describes where the plants grew, whether in fields, or woods, or on the roadside. Whether they grew in the ground or on wood, and finally the colour of the plant in a fresh condition. They should then be enclosed in a strong cardboard box or tin can to protect them from being crushed, and addressed to

Department of Botany,
Ontario Agricultural College,
Guelph, Ont.

KEY TO THE MUSHROOMS DESCRIBED IN THIS BULLETIN.

The term mushroom is used to include all large fleshy fungi, whether edible or poisonous. The term toadstool is not used as it includes the same group of plants.

Fruit body umbrella shaped.
1. With gills—True Mushrooms (*Agaricaceæ*), Page 9-30.
2. With pores—Boletus (*Polyporaceæ*), Page 30-32.

Fruit body shelf-like or bracket-like.
1. With gills—True Mushrooms (*Agaricaceæ*), Page 9-30.
2. With pores—Polypores (*Polyporaceæ*), Page 30-32.

Fruit body with a wrinkled or honey-comb-like head—
Morels (*Helvellaceæ*), Page 32-35.

Fruit body horn-shaped and having a carrion-like odour—
Stinkhorns (*Phallaceæ*), Page 35-36.

Fruit body ball-like—Puff Balls (*Lycoperdaceæ*), Page 37-39.

Fruit body much branched.
1. Branches growing upright—Coral Fungi (*Clavariaceæ*), Page 39-40.
2. Branches growing downward—Hedgehog fungi (*Hydnaceæ*), Page 40-41.

Fruit body cup-shaped or saucer-shaped——Cup Fungi (*Pezizaceæ*), Page 41.

AGARICACEÆ (True Mushrooms)

In this group of fungi the fruit body is umbrella-shaped or shelf-like. On the under side of the cap are many thin plates, gills or lamellæ, which are packed closely together, side by side. The gills may be white or pink, or brown or black.

I. Gills white and remaining white.

A. With a distinct stalk or stripe in centre of cap.
1. Both volva and annulus present—*Amanita*, Page 9-11.
2. Volva present, annulus absent—*Amanitopsis*, Page 14.
3. Annulus present, volva absent.
   a. Gills free from the stalk—*Lepiota*, Page 12-14.
   b. Gills attached to the stalk—*Armillaria*, Page 14.
4. Neither volva nor annulus present.
   a. Plants with a milky juice—*Lactarius*, Page 19-20.
   b. Plants without a milky juice.
      *Flesh very brittle and somewhat granular or mealy, generally bright coloured—*Russula*, Page 18-19.
      **Flesh firm, fleshy or fibrous.
         †Stalk fibrous, plants medium-sized to large, never very small.
            ‡Gills notched at the stalk—*Tricholoma*, Page 16.
            ‡‡Gills running down the stalk.
               §Gills thin—*Clitocybe*, Page 16.
               §§Gills thick and blunt—*Cantharellus*, Page 17.
         ††Stalk brittle or cartilaginous.
            ‡Plants large—*Collybia*, Page 18.
            ‡‡Plants small—*Mycena and Omphalia.*
               (not described in this Bulletin)
         †††Stalk tough, plants leathery when dry—*Marasmius*, Page 20.
            (only one described.)

B. Without a distinct stalk or a stalk at one side of the cap.
  1. Cap thick and flesh—*Pleurotus*, Page 21.
  2. Cap fleshy at first, but becoming corky or leathery.
    a. Gills toothed on the edge—*Lentinus*, Page 22.
    b. Gills smooth on the edge—*Panus* (not edible).
    c. Gills split on the edge—*Schizophyllum*, (not edible).
  3. Caps corky from the first—*Lenzites*, (not edible).

II. Gills at first white, but becoming pink or flesh colored.

A. Stalk central.
  1. With a volva—*Volvaria*, Page 22.
  2. Without volva or annulus.
    †Stalk easily separated from the cap—*Pluteus*, Page 22.
    ††Stalk not easily separated from the cap.
      ‡Gills notched at the stalk—*Entaloma*, Page 23.
      ‡‡Gills running down on the stalk—*Clitopilus*, (none described.)

B. Stalk, none or attached to one side—*Claudopus*. (Not described.)
(Some too small to be of any value are omitted.)

III. Gills at first white or pink, but becoming yellowish, brown or rusty brown.

A. Stalk central.
  1. Veil cobwebby—*Cortinarius*, Page 23.
  2. Veil forming a distinct ring—*Pholiota*, Page 23-25.
  3. Veil and ring absent—(No good species).

B. Stalk absent or attached to the side—*Crepidotus*, Page 25.

IV. Gills at first pink, becoming dark brown in age.

A. Stalk with a distinct ring.
  1. Stalk easily separating from the cap, gills free—*Agaricus*, Page 25-27.
  2. Stalk not easily separating from the cap, gills attached to the stalk —*Stropharia*, Page 26.

B. Stalk without a distinct ring, veil hanging in fragments from the edge of the cap—*Hyphaloma*, Page 27.

V. Gills white or pink at first, then becoming black.

A. Cap decomposing to form an inky liquid—*Coprinus*, Page 28-30.

B. Cap not decomposing to form an inky liquid—*Paneolus*, Page 30

VI. Gills of various bright colours, red, yellow, purple, etc.

A. Gills lilac to purple.
  1. Without a veil, gills notched—*Tricholoma*, Page 16.
  2. With a cobwebby veil—*Cortinarius*, Page 23.

B. Gills yellow or orange.
  1. Plants with milky juice—*Lactarius*, Page 19-20.
  2. Plants without milky juice.
    a. Gills thick and blunt—*Cantharellus*, Page 17.
    b. Gills thin and sharp—*Clitocybe*, Page 16.

AMANITA (Mostly Poisonous Mushrooms).

This genus contains the deadly poisonous mushrooms so one should become thoroughly familiar with it. These mushrooms possess both the ring or annulus and the poison cup or volva. When very young the cap is enclosed in a sack, and as the mushroom enlarges the sack is broken so that part of it remains in the ground as a cup at the base of the stalk while the upper part may form loose scales on the top of the cap. The gills are at first hidden by a curtain or veil, which stretches across the space between the edge of the cap and the stalk. When the cap opens out the veil is torn away from the margin of the cap and forms a ring on the stalk. The gills are white at first and remain white, never becoming pink, or yellow, or brown or black.

There are several species of Amanita, nearly all of which are deadly poisonous. There are a few species of Amanita which are edible but it would be very unwise for any one, except an expert, to eat them. It is far better to let all species of Amanita alone rather than take even the slightest risk.

Fig. 3. Fly Agaric. Original. Note the volva or poison cup and the loose scales on the cap.

Fly Agaric (*Amanita muscaria*, Linn.). Deadly Poisonous. (Fig. 3.)

This fungus appears in July and August in groves and open woods or along roadsides near trees, usually preferring rather poor soil. It is called "Fly Agaric," because an infusion of the plant was at one time used as a fly poison. The plant is typically large and handsome.

The cap is 3 to 5 inches broad, rounded when young, nearly flat when old, yellow or orange or even bright red in colour, and covered with numerous angular scales, which are white or light yellow in colour, and can easily be brushed off. As the cap becomes old it fades out, so that it may become nearly white and the scales may be washed off by rains.

The stalk is 4 to 6 inches long, about one-half inch thick, usually white, but often yellowish in colour, hollow in age. The bottom of the stalk is enlarged into a prominent bulb, which is more or less rough and shaggy or scaly. The lower part of the stalk above the bulb is also shaggy.

The gills are white or slightly tinged with yellow, and do not become pink or brown as do those of many edible mushrooms.

The ring is quite large, white, and firmly attached to the stalk.

The main points to remember about this fungus are:—The yellow or orange cap with loose white scales. Gills white, never becoming pink or brown. Ring

large, white, firmly attached to the stalk. *The stalk enlarged at the base into a prominent shaggy or scaly bulb and the stalk shaggy between the bulb and the ring.*

The poison in this mushroom is known as muscarin. This substance, fortunately has an unpleasant bitter taste, so that the plant is seldom eaten even if collected by mistake. The poison does not act immediately, but the symptoms appear in from one-half to two hours, and are: vomiting and diarrhoea, with a pronounced flow of saliva, suppression of urine, giddiness, uncertainty of movement, derangement of vision. This is followed by stupor, cold sweats and weakening of the heart action.

Of course when symptoms such as these appear after eating mushrooms a physician should be sent for immediately.

The system should be freed of the undigested fungus as soon as possible. Strong emetics, such as zinc sulphate, apomorphine or warm mustard and water should be used. If these are lacking or produce no effect, tickle the throat with a feather or the finger to cause immediate and violent vomiting. This should be followed by a strong dose of castor oil.

Fig. 4. Frost's Agaric. Original.

Fig. 5.—Deadly Agaric. Half Natural Size (Original).

Frost's Agaric (*Amanita frostiana*, Pk.). (Fig. 4.)

This is much like the Fly Agaric, except it is somewhat smaller. It often accompanies the Fly Agaric but usually grows in denser woods. The mushroom is 2 to 3 inches high and the cap from 2 to 2½ inches broad.

The Deadly Agaric (*Amanita phalloides*, Fr.). Deadly Poisonous. (Fig. 5.)

This fungus is called the Deadly Agaric because it is extremely poisonous, and there is no known antidote for the poison.

The plant usually grows in the woods or along the borders of woods, but has also been known to appear in lawns. It generally appears in July and August.

It is quite variable in colour, varying from pure white through yellowish to olive. Some place the white forms in a different species.

The cap is 1.5 to 4 inches broad, at first bell shaped, finally nearly flat, fleshy, viscid or slimy when fresh, smooth, often with a few loose white scales. The colour varies from white through yellow to olive green, the dark forms being more common in Ontario.

The stalk is 2 to 8 inches long, one-quarter to one-half an inch thick, hollow, white, or coloured like the cap, but lighter in shade, becoming discoloured on handling. It ends in an abrupt bulb which generally has a sharp rim standing up around it, forming a sort of cup, called poison cup or volva. This poison cup is usually deeply buried in the soil, so that in order to find it, it is necessary to dig the plant up.

Gills white and remain white, never becoming pink or brown.

The ring is white, prominent, and is high up on the stalk close to the cap. The ring is attached to the stalk, not loose as in the smooth white mushroom or parasol mushroom.

The poison in the Deadly Agaric is phallin. This poison, unfortunately, has no pronounced taste or odour, and gives no warning of its presence. Unfortunately, also, the symptoms of poisoning do not manifest themselves until nine to fourteen hours after the fungus is eaten. There is then considerable abdominal pain, and there may be cramps in the legs accompanied by convulsions and even lock-jaw and other tetanic spasms. The pulse is weak and abdominal pain is rapidly followed by vomiting and extreme diarrhoea, the intestinal discharges assuming the rice-water condition characteristic of cholera. These later symptoms persist, generally without loss of consciousness, until death ensues, which happens in from two to four days.

There is no known antidote for phallin. The undigested portions of the fungus should be removed from the stomach and intestines by methods similar to those suggested under the Fly Agaric. If the poison already absorbed is not too great, it may wear itself out and the patient recover.

Of course when symptoms of poisoning appear a physician should be sent for immediately.

THE DESTROYING ANGEL (*Amanita verna*, Bull.). DEADLY POISONOUS. (Fig. 6.)

This fungus is probably the cause of more cases of mushroom poisoning than any other.

The plant is pretty, clean, pure white and attractive.

It usually occurs in the woods or near them, but may grow in lawns newly made from forest soil. It is generally found in June and July.

The cap is 1.5 to 4 inches in diameter, at first bell shaped, later becoming nearly flat; *pure white, shining, viscid or slimy when fresh.*

The stalk is 2 to 6 inches long, one-quarter to one-half inch thick, pure white, hollow in age. The stalk ends in an abrupt *bulb*, with a free border closely surrounding the base of the stalk and forming the poison cup or volva. This may be seen in even young specimens as shown by Fig. 6. This poison cup is buried in the soil, so that in order to see it, it is usually necessary to dig the plant up. For this reason wild mushrooms growing in the soil should always be dug, not pulled up or broken off.

The gills are pure white and remain white, never becoming pink or brown.

The ring is broad and high up on the stalk, just under the cap. It is firmly attached to the stalk, and is not loose, as in the smooth, white mushroom.

Since this is our most poisonous mushroom its main characters should be thoroughly learned and remembered.

The cap is pure white, shining and slimy when fresh. The stalk is pure white, ending in a distinct poison cup or volva. Gills pure white and remain white. Ring white, broad, high upon the stalk to which it is firmly attached.

The poison in this fungus is the same as that in the Deadly Agaric, and the symptoms of poisoning and treatment are the same.

Fig. 6. Destroying Angel. Original. Note particularly the volva or poison cup.

LEPIOTA.

In this genus the gills are white and free from the stalk, there is a prominent ring which is often moveable, *i.e.*, it can be slipped up and down on the stalk; but there is no poison cup or volva. The plants are edible but care must be taken to distinguish them from Amanitae. There are three common species.

Parasol Mushroom (*Lepiota procera*, Scop.). Edible. (Fig. 7.)

This is one of our striking mushrooms, and is not inappropriately named. It grows in pastures, lawns, gardens, along roadsides, and in open woods in late summer and early autumn.

The cap is at first bell shaped, later becoming parasol shaped. It is 2 to 5 inches in diameter, at first greyish or brownish red, but as the cap expands the coloured surface breaks up into scales, showing the white flesh underneath. Finally the cap becomes shaggy in appearance.

The stalk is 4 to 8 inches long, one-sixth to one-quarter of an inch in diameter, the same colour as the cap, and generally becomes hollow in age.

The gills are white, free from the stem, and closely crowded.

The ring is stout, narrow, and usually quite free from the stem, so that it may be moved up and down.

White Mushroom or Smooth Mushroom (*Lepiota naucina*, Fr.). Edible. (Fig. 8.)

This mushroom grows in lawns, pastures and along roadsides, and is most abundant in September and early in October. The plant is entirely white or in old specimens somewhat buff.

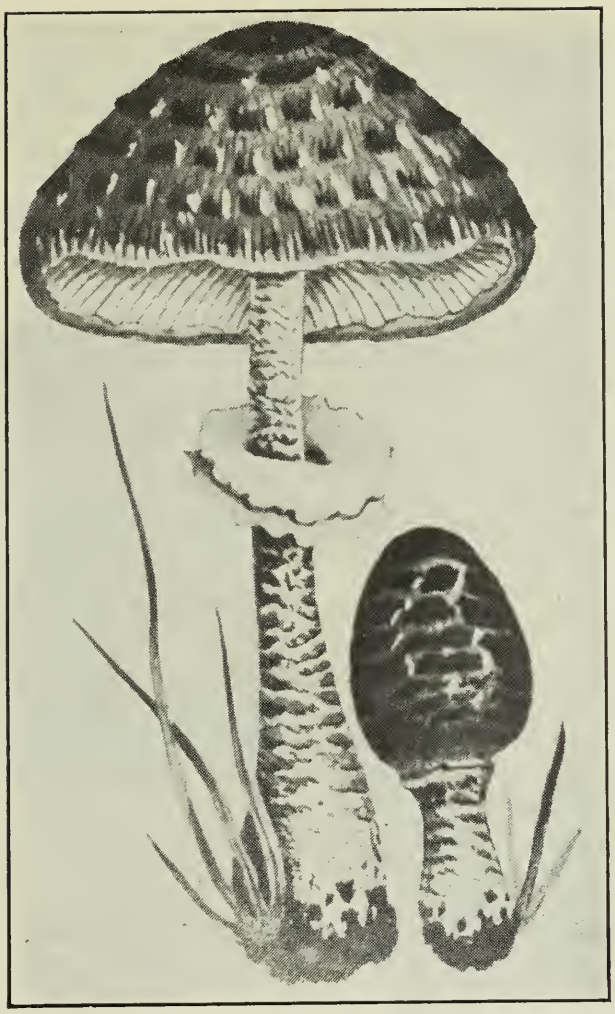

Fig. 7. Parasol Mushroom (after Massee).

Fig. 8. White Mushroom. Original. Note the absence of the volva or poison cup even in young stage.

The cap is 2 to 4 inches broad, globose to hemispheric, entirely white or slightly tinged with buff, and smooth. The stalk is 1½ to 3 inches long, one-third to one-half an inch thick, often hollow, white and generally with a *smooth* bulb at the base. The gills are free from the stalk, white or a dirty pink in old specimens.

The veil at first hides the gills, later the veil breaks away from the edge of the cap and forms a ring on the stalk. The ring often fits loosely to the stalk and may be slipped up and down.

CAUTION. Although this mushroom is very good, care must be taken to distinguish it from some deadly poisonous plants which sometimes grow in the same situations. The white mushroom described here, although white is not shiny, is dry, not slimy or viscid, and has a smooth bulb at the base of the stalk, not a shaggy bulb or cup.

CRESTED MUSHROOM (*Lepiota cristata*, A. & S.). EDIBLE. (Fig. 9.)

This is a very pretty little mushroom growing in lawns and on roadsides. It is from 1½ inches to 2 inches high and the cap is from one-half inch to 1½ inches broad. The top of the cap is ornamented with numerous fine reddish brown scales on a white background, the centre of the cap usually has a small reddish brown central spot. The gills are white. The stem is slender, white and bears a small white ring.

AMANITOPSIS.

This genus is much like Amanita except there is no ring. That is, the mushroom has a cap and stalk and volva or poison cup, but the ring on the stalk is not formed. The species are said to be edible but they are so easy to mistake for species of Amanita that it is best to leave them alone.

SHEATHED AGARIC (*Amanitopsis vaginata* (Bull.), Roz.). (Fig. 10.)

The Sheathed Agaric is widely distributed in woods. The plant is from 2½ to 6 inches high and the cap 1½ to 3 inches broad. The cap is somewhat bell shaped with fine ridges on the margin. It varies in colour from nearly white through grey to light brown. The gills are white. The stalk is slender and white. There is *no ring*. At the base of the stalk there is a white volva or poison cup which forms a close fitting sheath around the base of the stalk.

This mushroom is edible but it so closely resembles the Deadly Agaric (Amanita phalloides) that it is best to leave it alone.

HONEY AGARIC (*Armillaria mellea*, Vahl.). EDIBLE. (Fig. 11.)

This mushroom grows on rotting wood and may be found on logs or at the base of trees, generally in clusters of three or four to as many as a dozen or more.

The plant varies in size, generally 4 to 6 inches high and the cap 2 to 4 inches broad.

The cap is light yellow or honey coloured. The gills white, and firmly attached to the stalk. The stalk is white and generally fibrous or stringy. There is a soft, white ring on the stalk which is easly destroyed and often not seen. There is no volva or poison cup.

This mushroom is edible but not of good flavour unless taken when very young. It is hardly worth collecting.

Fig. 9. Crested Mushroom. Original.

Fig. 10. Sheathed Mushroom. Original. Note the absence of a ring.

Fig. 11. Honey Agaric. Original.

Fig. 12. Blue Hat or Bluet. Original.

TRICHOLOMA.

In this genus are placed all mushrooms having white spores, but which have no ring or volva and the gills notched at the stalk. The plants are all fleshy but firm. The gills are mostly white but one species has gills which are lilac to light purple.

Blue Hat or Bluet (*Tricholoma personatum*, Fr.). Edible. (Fig. 12.)

This mushroom is very pretty. The cap and stalk are lilac or light purple when young but fade to nearly white when old.

The cap is from 2 to 3 inches broad, thick and fleshy. Gills lilac in colour and notched at the stalk. The stalk is short, thick, solid and generally swollen or bulbous at the base. There is no poison cup, *i.e.*, volva, or ring.

White Hat or White Tricholoma (*Tricholoma album*).

This mushroom is about the same shape and size as the preceding, but is pure white. It is edible but not especially desirable.

Sulphur Hat (*Tricholoma sulphureum*, Bull.). Poisonous.

This mushroom is sulphur yellow in colour. The cap is 1 to 3 inches broad, thick and fleshy. The gills yellowish and notched at the stalk. The stalk is 2 to 4 inches long, firm, and bulbous at the base, sulphur yellow. There is no ring or poison cup.

The plant has a strong, disagreeable odour. It grows in the woods on old leaves and on rotting logs. The plant resembles the blue hat but is sulphur yellow instead of blue.

CLITOCYBE.

These mushrooms are generally funnel shaped or top shaped with the gills running down the stalk. There is no ring or poison cup. Gills are white, but in a few cases yellow. The plants are firm, fleshy or fibrous.

Tufted Mushroom (*Clitocybe multiceps*, Pk.). Edible. (Fig. 13.)

This mushroom grows in dense clusters in well manured grass land.

The caps are white or light grey, top shaped and there may be as many as a dozen in a cluster. The caps are 1½ to 3 inches across and very firm and fleshy. The stalk is white and firm and the gills run down the stalk. There is no ring and no poison cup or volva.

Tufted Honey Top (*Clitocybe monadelpha*, Morg.). Edible.

This mushroom also grows in dense clusters but is usually found at the base of stumps. The caps are light yellow or honey coloured. It can easily be mistaken for the Honey Agaric but the tufted honey top lacks a ring and is not so fibrous. The plant is edible but it generally has a woody flavour.

Jack O'Lantern (*Clitocybe illudens*, Schw.). Poisonous. (Fig. 14.)

This mushroom is yellow to saffron in colour and occurs in clusters on decaying wood. The caps are more or less funnel shaped and 4 to 6 inches broad. The gills are yellow and extend down the stem for a considerable distance. The whole plant is phosphorescent and in a dark room is surrounded with a distinctly ghostly glow. For this reason it is often called Jack O'Lantern, or Fox Fire. The plant is a violent emetic and should be avoided.

CANTHARELLUS.

These mushrooms are funnel shaped and the gills extend downward on the stalk. The gills are thick and blunt, often branched, not thin and plate-like as in most other mushrooms.

Fig. 13. Clustered Mushroom. Original.

Fig. 14. Jack O'Lantern. Original.

Fig. 15. Chantarell. (After Thaxter.)

Fig. 16. Rooted Mushroom. Original.

CHANTARELLE (*Cantharellus aurantiacus*, Fr.). EDIBLE. (Fig. 15.)

This mushroom is funnel shaped and a deep yellow in colour. The gills are branched and low and blunt. It can be distinguished from the Jack O'Lantern by its low, branched gills, and the firm fleshy character of the stalk, which is never fibrous, and the absence of the glow when put in the dark.

COLLYBIA.

Many of these mushrooms are medium sized to large and very graceful in appearance. The gills are white or slightly tinged with yellow. The stalks are slender and very brittle or cartilaginous.

Rooted Mushroom (*Collybia radicata*, Rehl.). Edible. (Fig. 16.)

This is a very common mushroom around stumps. The cap is smoky grey and somewhat sticky when moist. It is 2 to 4 inches across. Gills pure white. The stalk is dark, smoky grey, slender and very brittle, 3 to 8 inches long. When the plant is pulled up a long tapering root-like portion remains attached to the stalk.

Velvet Stem (*Collybia velutipes*, Curtis.). Edible. (Fig. 17.)

This mushroom occurs on rotting wood in dense clusters of six to twenty or more. The caps are light yellow to dull yellow, slightly sticky when moist and 1 inch to 2 inches in diameter. The gills are white or light yellow. The stalk brown and velvety. It may be found on rotting wood from early spring to late fall.

Fig. 17. Velvet Stem Mushroom. Original.

Fig. 18. Scarlet Cap. Original.

RUSSULA (Coloured Mushrooms).

These mushrooms are mostly bright coloured, red, pink, green, sometimes white. There is no ring or poison cup, and the flesh is very brittle and mealy or porous in appearance. The flesh shows mingling of fine threads and little vessels. Many are reputed to be poisonous.

Scarlet Cap (*Russula emetica*, Fr.). Reputed to be Mildly Poisonous. (Fig. 18.)

This fungus occurs very commonly in the woods from summer until autumn. It gets its name from the bright scarlet cap. It is hot and peppery to the taste, and some report it to be mildly poisonous, while others say that it is edible.

The cap is 1.5 to 3 inches wide, thin, brittle, deep pink to rich red; furrowed near the edge, rounded when young, depressed in the centre when old.

The stalk is 2 to 3 inches long, white or tinged with yellow. Very brittle.

There is no ring and no volva or poison cup.

GREEN CAP (*Russula virescens*, Fr.). POISONOUS?

This mushroom resembles the preceding one but the cap is green. The plant is looked on with suspicion.

LACTARIUS (Milky Mushrooms).

These mushrooms are mostly funnel shaped and give out a milky juice when cut or broken. In some the milk is orange, some white, some white at first then becoming golden yellow; one has blue milk.

ORANGE FLOW (*Lactarius deliciosus* (L), Fr.). EDIBLE. (Fig. 19.)

This mushroom occurs abundantly in balsam and spruce woods in the autumn. When broken the flesh gives out an orange-coloured juice. The plants have a pleasing fruity odour.

The cap is 3 to 5 inches broad, funnel shaped, yellow or pale orange with bands of lighter colour; slightly hairy; juice or milk orange coloured.

The stalk is 2 to 3 inches long, about an inch thick, hollow and brittle.

The gills are yellow or orange, running down on the stem.

There is no ring.

FIG. 19.—Orange Flow. Edible. Two-thirds Natural Size (Original).

SHAGGY LACTARIUS (*Lactarius torminosus*, Fr.). REPUTED TO BE POISONOUS. (Fig. 20.)

This mushroom is common on the ground in the woods. The caps are funnel shaped, 2 inches to 5 inches in diameter; pink or reddish in colour, zoned or spotted with darker colour. The margin of the cap is shaggy with long hairs which often extend nearly to the centre of the cap. The milk is white or whitish, the plant does not have the pleasant fruity odor of the Orange Flow. The flesh and milk have a sharp acrid taste.

PEPPER MUSHROOM (*Lactarius piperatus*, Fr.).

Some authorities say this mushroom is edible while others state that it is poisonous.

The plant is pure white. The cap is funnel shaped, the gills extend well down on the stalk and exude a white milky juice when bruised. The juice is

very acrid and causes an intense burning sensation when tasted. The stalk is short, thick, solid and also gives out a white milky juice when bruised.

Fig. 20. Shaggy Lactarius. Original.

MYCENA.

These are very small and fragile mushrooms and not important.

OMPHALIA.

These mushrooms are also small and unimportant.

MARASMIUS.

These mushrooms are mostly too small and tough to be edible; one species is, however, large enough to become valuable as a food plant.

Fig. 21. Fairy Ring Mushroom. Original.

Fairy Ring Mushroom (*Marasmius oreades*, Fr.). Edible. (Fig. 21.)

This mushroom grows in lawns and pastures forming distinct rings or parts of rings. The caps are white with a light brownish tinge and 1 to 2 inches in

diameter; gills white; stem white and slightly hairy. When young the caps are tender but they become tough and leathery when they begin to dry up.

The caps may be dried easily and have the appearance and taste of fresh mushrooms when soaked in water.

PLEUROTUS (Oyster Mushrooms).

These mushrooms generally grow in dense clusters on logs and stumps; one species grows on elm exclusively. The caps are usually shell-like with no stalk or with the stalk at one side of the cap.

Elm Mushroom (*Pleurotus ulmarius*, Bull.). Edible.

This mushroom grows on elm logs and stumps and often develops from knot holes in elm trees. The caps are white or grey, large, 3 to 6 inches across and thick, solid and fleshy. Gills are white. There is no ring or poison cup. The stalk is generally near one side of the cap.

Fig. 22.—White Oyster Mushroom. Edible. Natural Size (Original).

White Oyster Mushroom (*Pleurotus ostreatus*, Jacq.). Edible. (Fig. 22.)

This mushroom is so named because the white, one-sided caps resemble, to some extent, oysters. The plant grows on dead logs and stumps in dense clusters, the caps overlapping each other. It occurs in late summer and autumn.

The cap is one sided, with a very short, solid stalk or none, 2 to 8 inches wide, white or greyish, thick and fleshy.

The stalk is at one side, short, thick, solid, or absent.

The gills are white, running down the stalk.

Dark Oyster Mushroom (*Pleurotus serotinus*, Schrad.). Edible.

This mushroom resembles the preceding one, but is darker in colour. It also grows on logs and stumps, either occurring singly or in small, overlapping clusters. It is common in damp woods in the autumn.

The cap is attached by one side, 2 to 5 inches wide, sometimes yellow, but more often greenish brown or with an olive tinge. The flesh under the "skin" or pellicle is white or whitish.

The stalk is very short or none.

The gills are white or with a yellowish tinge.

In cooking this mushroom it is best to remove the dark skin or pellicle, as it improves the appearance of the food, although it does not improve the flavour.

LENTINUS (Scaly Mushrooms). (Fig. 23.)

These mushrooms have large caps which are usually scaly. When young they are firm and fleshy, but become corky or woody when old. The gills are white and toothed or irregularly torn on the margin. They are mostly too tough to be edible but the Scaly Cap (*Lentinus lepideus*, Fr.) is good when very young.

MUSHROOMS WITH PINK GILLS.

In this group of mushrooms the gills are at first white and then become pink or flesh coloured.

Fig. 23. Scaly Mushroom. Original.

Fig. 24. Fawn Cap. Original

Silky Mushroom (*Volvaria bombycina* (Pers.), Fr.). Edible.

This mushroom is edible but care must be taken not to mistake the Deadly Agaric or Destroying Angel for it.

This mushroom has a large cap, 2 inches to 10 inches in diameter, all white and somewhat silky, usually bell-shaped. Stalk 3 to 4 inches long, white and smooth. The gills are first white then pink. At the base of the stalk there is a prominent bag, the poison cup or volva, but there is no ring.

The mushroom differs from the Deadly Agaric and the Destroying Angel, in that its gills become pink instead of remaining white. There is no ring in Volvaria, whereas it is present in the deadly poisonous mushrooms.

Fawn Cap (*Pluteus cervinus*, Schaeff.). Edible. (Fig. 24.)

This is a large mushroom growing on rotten wood. The cap is 2 to 5 inches in diameter, brown to fawn colour, bell shaped at first then becoming nearly flat. The gills are first white, then become pink. They do not touch the stalk but are free from it. The stalk is 3 to 6 inches long and brownish in colour, often deeply buried in the rotten wood. The stalk can be easily separated from the cap to which it seems to be united by a ball and socket joint.

One of our best mushrooms.

ENTOLOMA.

In these plants there is no ring or poison cup. The gills are at first white then become pink or salmon coloured. The gills are attached to the stalk but are usually notched.

Large Entoloma (*Entoloma grande*, Pk.). Poisonous.

This mushroom has a cap 4 to 6 inches wide, white or brownish, smooth at the edge, but somewhat wrinkled near the central knob. The stalk is 4 to 6 inches long and white in colour. The gills are so deeply notched that they are almost free from the stalk. The stalk does not separate readily from the cap. The odour and taste are somewhat like meal, but leave a burning or biting feeling in the mouth. It grows on the ground in the woods. Care should be taken to distinguish this from the Fawn Cap (*Pluteus cervinus*).

Stinking Entoloma (*Entoloma graveolens*, Pk.).

Probably not poisonous but has a very unpleasant odour. This mushroom may be white to brown with a purple or lilac tint, and resembles the Blue Hat or Bluet (*Tricholoma personatum*). It can be readily distinguished by its unpleasant fetid odour.

MUSHROOMS WITH RUSTY BROWN GILLS.

In this group of mushrooms the gills are at first white or rusty, finally becoming yellowish brown or dark rusty brown.

CORTINARIUS.

In these mushrooms there is no poison cup or ring and the gills become rusty brown. When the plants are young numerous fine threads connect the edge of the cap with the stalk, so that the gills are partially hidden by the cobwebby veil.

False Blue Hat or False Bluet (*Cortinarius violaceus*, Fr.). Edible. (Fig. 25.)

The cap is 3 to 5 inches wide, dull to deep violet but fading to lilac when old. The stalk is 3 to 4 inches long, bulbous at base and solid. The gills are lilac at first then become rusty brown. They are notched at the stalk as in the Blue Hat but are at first partially hidden by a cobwebby veil. It grows on the ground in the woods.

Slime Capped Mushroom (*Cortinarius coerulescens*, Fr.). Poisonous? (Fig. 26.)

This is a slender mushroom with a cap 1 to 2 inches wide, slimy when fresh, and brown in colour. The stem is slender and the gills are hidden at first by the cobwebby veil. It is not a tempting looking plant. There are several slimy mushrooms, none worth gathering, and will seldom be collected.

PHOLIOTA.

These mushrooms have no poison cup but a ring is present on the stalk. The gills are attached to the stalk and become rusty brown or dark brown in colour.

Fig. 25. False Bluet. Original.

Fig. 26. Slimy Cap Mushroom. Original.

Fig. 27. Early Mushroom. Original.

Fig. 28. Hard or Cracked Mushroom. Original.

Early Mushroom (*Pholiota praecox*, Pers.). Edible. (Fig. 27.)

This mushroom appears usually in late spring or early summer. The cap is white to light tan colour and 1 inch to 2 inches in diameter; generally hemispherical. The stalk is slender, white and about 2 inches long. The ring is small and may be lost in old specimens. The gills are at first white, then brown. The plant grows in grassy places, lawns, roadsides, pastures.

Cracked Mushroom or Hard Mushroom (*Pholiota dura*, Bolt.). Edible. (Fig. 28.)

This mushroom occurs in midsummer and can frequently be found in stubble fields or even in cultivated fields.

The caps are medium sized to larger, 2 inches to 4 inches in diameter, white or light yellow and usually cracked into irregular areas. The flesh is firm and thick. The stalk is white, about 3 inches long. There is a distinct ring on the stalk and often a ragged fringe on the edge of the cap. The gills become rusty brown.

This is one of our best mushrooms.

Scaly Cap (*Pholiota squarrosa*, Mull.). (Fig. 29.)

Edible but not very desirable.

This mushroom grows in clusters on wood, often at the foot of trees. The cap is yellow to rusty brown and covered with shaggy scales. The cap is 3 to 5 inches in diameter, the stem is 4 to 8 inches long and is shaggy or scaly. There is a prominent ring on the stalk. The gills become rusty brown. The stalk is quite tough and the whole plant has a woody taste.

Brown Gilled Shelf Mushroom (*Crepidotus mollis*, Schaeff.)

This mushroom resembles the oyster agaric but the gills are brown instead of white. Edible but not very good.

MUSHROOMS WITH DARK BROWN GILLS.

These mushrooms have gills that are pink at first then turn a deep purple brown, almost black. The common cultivated mushroom belongs here. In most cases the "mushroom with pink gills" is one of these forms.

AGARICUS.

These mushrooms have no poison cup, but there is a very conspicuous ring on the stalk. The stalk and cap can be easily separated. The gills are not attached to the stalk and are at first pink, then become dark brown.

Common Mushroom, Cultivated Mushroom (*Agaricus campestris*, Linn.). Edible. (Fig. 1.)

This is the mushroom commonly cultivated. It also grows wild, and may be found in lawns, meadows, pastures, cultivated fields, greenhouses, and is very common on well-cared-for golf links. It may be found from late spring until fall, but is more abundant in summer and early autumn, when nights are cool and the days warm and not too dry.

The cap 2 to 4 inches wide, at first hemispherical, later becoming flat; white or with brown threads over the surface, giving a greyish or brownish silky appearance; flesh solid and white. The stalk or stipe is 2 to 4 inches long,

one-half to three-quarters of an inch thick, firm, coloured like the cap. The gills are free from the stalk at the inner end; at first pink, later becoming purple brown or nearly black. The gills are at first hidden by the veil which later is torn apart, leaving a fringe on the edge of the cap and a small ring on the stalk.

FIELD MUSHROOM or HORSE MUSHROOM (*Agaricus arvensis*, Schæff.). EDIBLE.

Grows in fields and meadows.

This is very much like the common mushroom, except that the stalk is longer and becomes hollow in age and the veil is thicker, so that the ring or annulus may appear double. The gills are at first pink, then turning brown. Some spawn companies claim to have the "spawn" of this species for sale.

Fig. 29. Scaly Mushroom. Original.

Fig. 30. Dung Mushroom. Original.

RODMAN'S MUSHROOM (*Agaricus rodmani*, Pk.). EDIBLE.

This mushroom occurs very commonly in cities and towns, on lawns and boulevards. The plant is entirely white with tinges of yellow. It is about the same size as the common mushroom, but the stalk is very short and solid. The veil is quite thick and forms a distinct double ring or annulus. The gills are at first pink, then dark brown. Some seed companies claim to have the "spawn" of this species for sale.

DUNG MUSHROOM (*Stropharia stercoraria*, Fr.). (Fig. 30.)

Edible but hardly desirable.

This little mushroom occurs frequently on dung. The plant is from 2 to 3 inches tall with a very slender stalk which is yellowish in colour. The cap about one inch broad, yellow to light brown. The gills are at first pink, then dark brown and are attached to the stalk. There is a small ring on the stalk but no volva or poison cup.

SCALY or FOREST MUSHROOM (*Agaricus placomyces*, Pk.). EDIBLE. (Fig. 31.)

This mushroom grows in woods or borders of woods, coming up from the fallen leaves. It most frequently occurs where there are some hemlock or pine trees. It may be found from June to September.

The cap is 2 to 5 inches in diameter, at first rounded, finally nearly flat, but thicker in the centre. It is first brown, but as the cap expands the brown surface breaks up into numerous small scales exposing the white flesh below. The stalk is 2 to 5 inches long, one-quarter to one-third of an inch in diameter, white, slightly bulbous at the lower end, often becoming hollow. The gills are free from the stalk, at first white, but very soon becoming pink and finally dark brown. The veil is thick, so that a large prominent ring is formed which sometimes appears double.

Fig. 31.—Scaly or Forest Mushroom. Edible. Natural Size (Original).

HYPHOLOMA,

The plants in this genus all have purple gills, which are attached to the stalk. The veil generally breaks away from the stalk and hangs as a fringe from the edge of the cap. The ring is inconspicuous or absent. There is no volva or poison cup.

Brick Red Mushroom (*Hypholoma sublateritium*, Schaeff.).

Edible, but sometimes bitter.

This mushroom grows in dense clusters on old stumps, often appearing on the ground where the fungus is growing on buried pieces of wood.

The caps are brick red in colour, often brighter coloured on the margin, and 2 to 3 inches broad. The stalks are slender, often curved. The gills are nearly white at first, then become dull yellow and finally purple brown, often mottled. The gills are at first hidden by a veil which breaks away from the stalk and then hangs as a ragged curtain from the margin of the cap. The ring is inconspicuous.

Brown Mushroom (*Hypholoma appendiculatum*, Bull.). Edible. (Fig. 32.)

This mushroom looks much like the preceding one but the mushrooms often grow singly as well as in dense clusters. The caps are thin and brown.

BLACK GILLED MUSHROOMS.

In this group of mushrooms the gills become black when the plants become mature, although they may be pink or even white in young stages. The most conspicuous plants of this group melt down into an inky liquid when they become mature.

COPRINUS.

This genus is characterized by the melting down of the plant to form an inky liquid at maturity.

Fig. 32. Brown Mushroom. Original.

Fig. 33. Shaggy Mane. Original.

Shaggy Mane (*Coprinus comatus*, Fr.). Edible. (Fig. 33.)

The Shaggy Mane is one of the most prized mushrooms by those who know it. The plant is quite large and distinguished by its shaggy cap, which melts down, forming inky liquid as the plants become old. It occurs in lawns and other grassy places, especially in richly-manured ground. The plants sometimes occur singly or a few together, but often quite large numbers of them appear in a small area. They occur most abundantly during quite wet weather, or after heavy rains, in late spring or early autumn, sometimes in summer.

The cap is cylindrical, usually brownish at first, but the surface becomes broken up, forming shaggy scales and exposing the white flesh underneath. The cap is 4 to 7 inches long, 2 inches thick. As the plant becomes old the cap melts down into an inky liquid and wastes away.

The stalk is white, 6 to 9 inches long, thickened at the base and hollow.

The gills are at first white, then pink, changing to brown, finally becoming black and melting down into an inky liquid.

There is a ring in young specimens, but this usually disappears.

Since the cap and gills turn into an inky liquid the plants should be gathered early in the morning before the cap and gills have begun to change colour or when the gills near the edge are flesh colour. It may be also eaten after the gills become black, but the inky looking mass is not inviting.

INK CAP (*Coprinus atramentarius* (Bull.), Fr.). EDIBLE. (Fig. 34.)

The Ink Cap occurs in much the same places as the Shaggy Mane and is some times found accompanying it, but is usually more common and abundant. Sometimes the plants are scattered, but usually there are ten or twenty in a dense cluster.

The cap is egg-shaped or oval, generally smooth or somewhat scaly, 2 to 3 inches long, silvery grey, or ashen grey, or smoky brown. At maturity the cap melts down into an inky liquid.

The stalk is 3 to 4 inches long, one-half inch thick, hollow, the same colour as the cap, or in some a little lighter in colour. There is no distinct ring, but an irregular raised ridge about the stalk at the bottom of the cap.

The gills are packed very close together; at first whitish, soon becoming pink, then moist and black, and dropping away as an inky liquid.

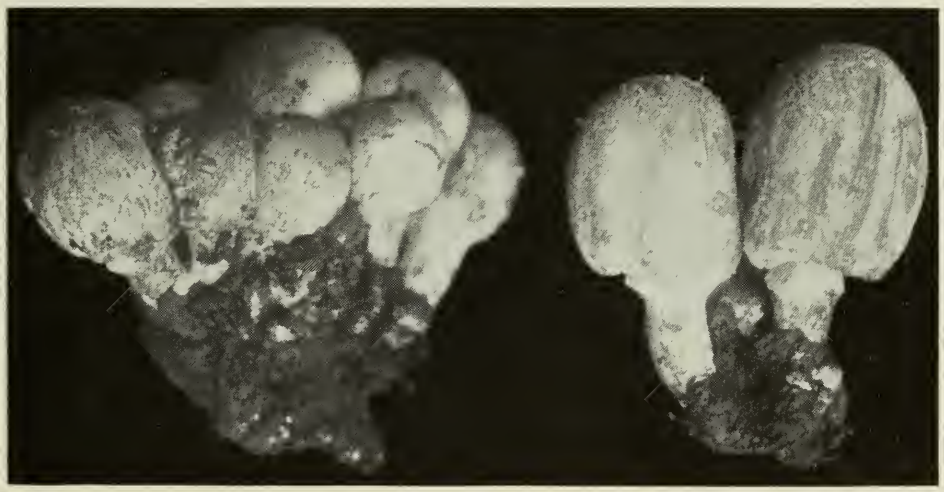

Fig. 34. Ink Cap. Original.

Like the Shaggy Mane, this mushroom must be gathered early if one is to enjoy it, as on warm days the cap may be entirely gone by noon, but if they are gathered early and kept in a cool, dry place, they may be preserved for a few hours.

MICA CAP (*Coprinus micaceous* (Bull.), Fr.). EDIBLE. (Fig. 35.)

This little mushroom is generally very abundant in late spring and early summer, and sometimes in the autumn. It grows about the bases of stumps or trees, or from wood buried in the soil. It forms in dense tufts of ten to thirty, sometimes several hundred coming up from the roots of a dead tree or stump, forming large masses in the lawn or boulevard. It is sometimes found on logs in the woods.

The plant gets its name from the numerous glistening scales on the cap, causing it to appear as if powdered with mica.

The cap is oval, then bell shaped, with fine lines from the centre to the edge. When young it is covered with glistening mica-like scales. The colour is tan, light buff or tawny yellow. The cap is 1 to 2 inches broad.

The stalk is slender, smooth, white, hollow, 1 to 3 inches long.

The gills are at first white, finally becoming black.

In wet weather the cap and gills melt down into an inky liquid, but may simply dry up at other times.

PANAEOLUS.

These mushrooms are very frequently found on dung or in very heavily manured soil. The gills become black and are frequently mottled. They differ from the Ink Caps in not melting down to an inky liquid. As a rule the plants are small.

Fig. 35.—Mica Cap. Edible. Natural Size (Original).

Butterfly Mushroom (*Panaeolus papilionaceus*, Fr.). Poisonous. (Fig. 36.)

This is an attractive little mushroom generally growing on dung. The cap is about one inch broad and is smooth at first, then becomes scaly. The stalk is slender, hollow, white at first but soon becomes blackened by the falling spores. The gills are black and become spotted as the spores fall away.

It is reported to be mildly poisonous causing a mild form of intoxication.

Murrill has described a similar form which sometimes invades mushroom beds. He describes the plant (*Panaeolus venenosus*, Murr.) as causing serious poisoning.

POLYPORACEAE (Bracket Fungi or Polypores).

These fungi are usually bracket shaped or shelf-like with the under surface bearing numerous small holes like pin holes, called pores. In a few cases the plants are umbrella shaped with a central stalk but in place of gills the under side of the cap is filled with small holes or pores.

A—Plants umbrella shaped with a central stalk—Boletus, page 31.

B—Plants bracket shaped or shelf-like.

- (1) Pores occurring in separate tubes—Beefsteak fungus, Fistulina, page 32.
- (2) Pores occurring in the continuous substance of the under surface.
  - (1) Plants fleshy to corky, Polypores—Polyporus, page 32.
  - (2) Plants hard and woody, Fomes—too hard to be edible.
  - (3) Plants leathery, Polystictus—too tough to be edible.

BOLETUS

These plants resemble the common mushrooms in shape and are soft and fleshy but instead of bearing gills under the cap they have numerous small holes in cap substance.

Yellow Boletus (*Boletus luteus*, L.). Edible. (Fig. 37.)

This fungus has a cap 2 to 3 inches broad and yellowish brown to greyish brown in colour. The cap is smooth and somewhat slimy when moist. The stalk is 2 to 3 inches long and from one-half to three-quarters inch thick. There is a prominent ring on the stalk and the stalk is dotted with little dark points, both above and below the ring. It is common in woods having a sandy soil, found in summer and early fall.

Fig. 36. Butterfly Mushroom. Original.

Fig. 37. Yellow Boletus. Original.

Edible Boletus (*Boletus edulis*, Bull.). Edible.

This is a very large fungus, the cap being 4 to 8 inches across, and thick and fleshy. It varies in colour from yellowish brown to reddish brown. The flesh is white, not changing when bruised and has a sweet, nutty taste. The tubes are white when young becoming greenish when old. The stalk is stout, enlarged into a bulb at the bottom, covered with a net work of fine ridges. There is no ring.

Bitter Boletus (*Boletus felleus*, Bull.). Inedible. (Fig. 38.)

This fungus resembles the preceding but the mouths of the tubes are pink. The flesh is white changing to pink when bruised. The flesh is very bitter and unfit for food.

Peppery Boletus (*Boletus piperatus*, Bull.). Poisonous.

Resembles the preceding but the flesh is extremely acrid and peppery.

Lurid Boletus (*Boletus luridus*, Schaeff.). Poisonous.

This fungus is about the same size as the Yellow Boletus, that is 2 to 5 inches in diameter. The cap is smooth, slightly hairy and reddish brown or yellowish brown. The flesh is whitish, becoming blue when wounded. The tubes are yellowish with the mouths bright yellowish red or cinnebar red. This fungus contains the same poison as found in the Fly Agaric. It grows in open woods having a clay soil.

Beefsteak Fungus or Ox Tongue (*Fistulina hepatica* (Huds.), Fries.). Edible.

This is a large, heavy, fleshy fungus resembling a piece of raw beefsteak. The fruit body is shelf-like, about 2 to 6 inches across and attached by one side to logs and stumps. The flesh is thick, tough, streaked with dark and light reddish lines; the taste is somewhat acid. The tubes are yellowish and become plainly distinct.

POLYPOROUS.

In this genus the plants are mostly corky but a few are fleshy when young and edible. The fruit body is mostly bracket shaped and attached by one side. There are no gills but the under surface of the cap is filled with small holes or pores.

Fig. 38. Bitter Boletus. Original.

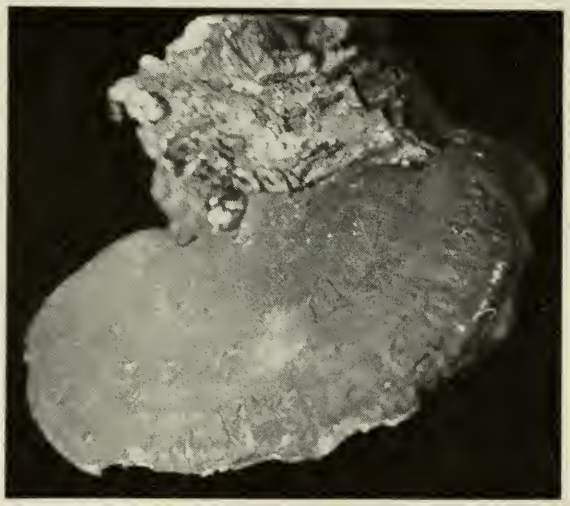

Fig. 39. Resinous Polypore. Original.

Resinous Polypore or Bracket (*Polyporus resinosus*, Schrad.). Edible. (Fig. 39.)

This bracket fungus is very common on rotting logs. The flesh is at first firm, somewhat tough, but becomes corky when old. When young it exudes a resinous substance which some consider objectionable. The bracket is 3 to 8 inches wide and dark velvety brown above, and nearly white below.

Sulphur Polypore (*Polyporus sulphureus*, Bull.). Edible. (Fig. 40.)

This fungus also occurs on rotting stumps and logs, the brackets occur in dense clusters and are sulphur yellow in colour. The flesh is at first soft but firm, but later becomes corky.

Birch Fungus (*Polyporus betulinus*, Fr.). Edible. (Fig. 41.)

This fungus is common on birch logs. The cap is somewhat hoof-shaped and is suspended by one side. It is white at first then becomes a smoky grey.

HELVELLACEAE—MORELS.

This group of mushrooms is easily distinguished. The stalk may be hollow or fluted, the cap firmly attached to the stalk and in some forms covered with broad shallow pits separated by a net work of low ridges, or the cap may be simply crisped or wrinkled.

The True Morels or Spring Morels—Morchella

In this genus the stalk and head are hollow. The cap is completely fused with the stalk and bears broad shallow pits separated by a network of low ridges. They are usually found in the spring or early summer.

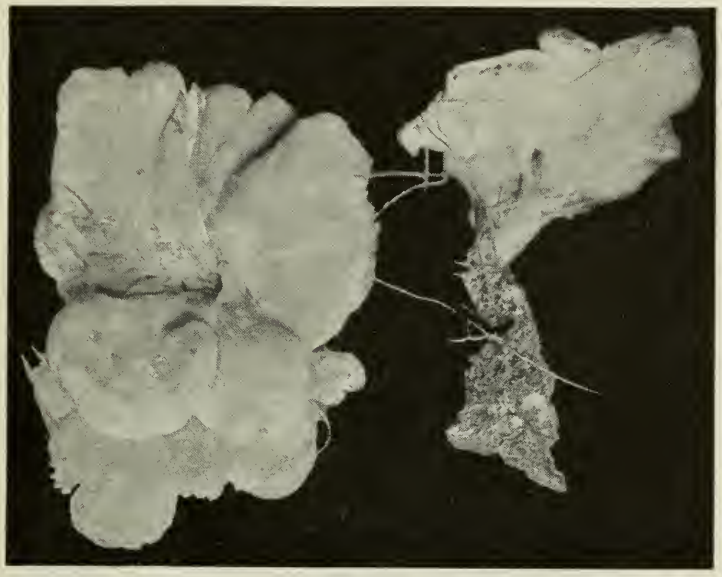

Fig. 40. Sulphur Polypore. Original.

Fig. 41. Birch Polypore. Original.

Fig. 42. Common Morel. Original

Fig. 43. Narrow Headed Morel. Original.

The Common Morel (*Morchella esculenta*, Pers.). Edible. (Fig. 42.)

This is one of the best of the few edible fungi which occur in abundance in the spring and early summer. (Fig. 42.) May and June are the usual months. They have the further advantage that there are no poisonous kinds closely

resembling them. They are not very variable either in form or colour. Both the cap and stalk are hollow, and the surface of the cap bears a number of prominent ridges joined together to form an irregular network. This distinguishes them from all the other fungi except the "stink horns", which differ in having the long stalk arising from a cup partly buried in the soil and having a penetrating, disagreeable odour. Even the "stink horns" are edible when young.

There are four species of Morel, but as they are all edible no separate descriptions of them are given.

NARROW HEADED MOREL (*Morchella angusticeps*, Pk.). EDIBLE. (Fig. 43.)

This Morel resembles the preceding but the head is much narrower, scarcely any wider than the stalk.

BIG STALKED MOREL (*Morchella crassipes* (Vent.), Pers.). EDIBLE. (Fig. 44.)

This Morel has a short head and a thick stalk. It grows in places similar to the two preceding.

Fig. 44. Broad stemmed Morel. Original.

Fig. 45. Fall Morel. Original.

FALL MORELS or SADDLE FUNGI (*Helvella*).

In this genus the stalks are smooth or fluted and the cap is saddle shaped or crisped or wrinkled. The plants are usually found in the fall, generally in the woods.

FLUTED STALK or FALL MOREL (*Helvella crispa*, Fr.). EDIBLE. (Fig. 45.)

This is a very pretty plant found growing in the woods in the fall. It is most common in coniferous woods, especially among pine.

The plant is from 2 to 6 inches high. The stalk is generally white or dusky grey and carved and fluted with irregular hollows and ridges. The cap is from 1 inch to 2 inches broad, white to brown and very much folded or crisped and wrinkled. It is fully as good as the Common Morel.

SADDLE CAP (*Helvella elastica*, Fr.). EDIBLE. (Fig. 46.)

This is a much smaller fungus occurring in the same situations as the Fluted Stalk. The stalk is white, slender and smooth. The cap is white becoming

greyish brown and saddle shaped. The plant is seldom more than 3 inches tall and the cap one-half to three-quarters inch wide. It is not as good as the preceding, the stalks are often tough.

THIMBLE CAP (*Verpa digitalisformis*, Pers.). EDIBLE. (Fig. 47.)

A small fungus found in spring. The stalk is white and slender about 2 inches long, and smooth. The cap is thimble shaped and fits over the top of the stalk like a thimble. The cap is generally greenish brown.

Fig. 46. Saddle Cap. Original.

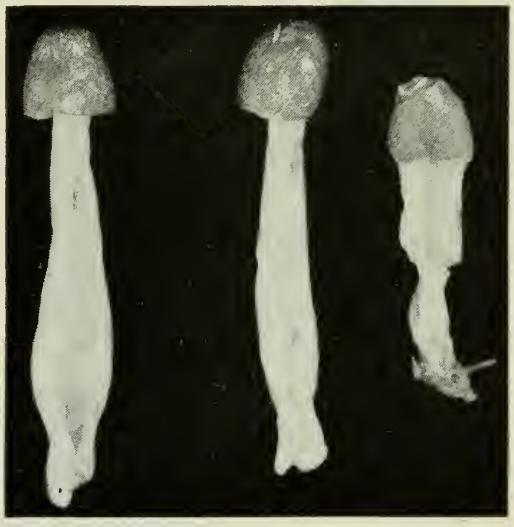

Fig. 47. Thimble Cap. Original.

Fig. 48. Netted or Frilled Stinkhorn. Original.

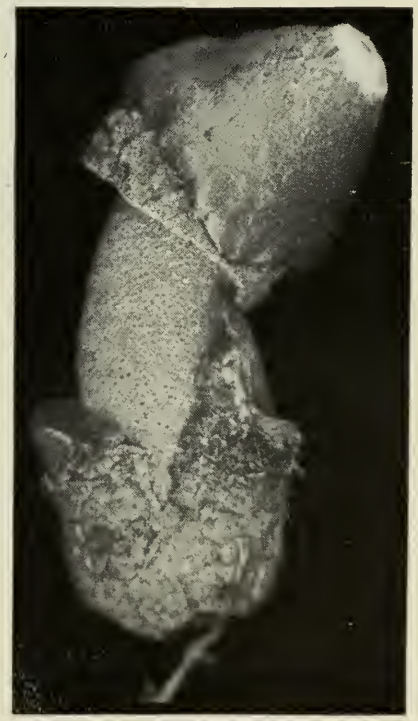

Fig. 49. Common Stinkhorn. Original.

PHALLACEAE OR STINKHORNS.

This is a peculiar group of fungi which, when mature, gives off a very unpleasant, carrion-like odour. It is probable that spores are carried by flies. In young stages the fruit bodies are egg shaped. Upon cutting open the egg the

stalk and cap can be seen inside, imbedded in a gelatin-like substance. In this stage the fruit body resembles that of the Deadly Agaric. At maturity the stalk rapidly elongates, often four to five inches in an hour, and carries up the brownish cap. Very soon the cap begins to melt down giving off the carrion-like odour.

FRILLED OR NETTED STINKHORN (*Dictyophora duplicata* (Basc.), Fisch.). (Fig. 48.)

This is the largest and most evil smelling of the stinkhorns. The fruit body is 6 to 8 inches high. The stalk arises from the "egg" leaving at its base the cup-like or bag-like volva or poison cup. The cap is about 1 inch to 2 inches broad and with shallow pits. The cap is at first brown but the brown substance dissolves and drops away leaving a white pitted cap which looks a little like a Morel. A delicate lacy frill or skirt hangs down from under the cap, reaching about half way to the base.

The plant is said to be edible in the egg stage but it resembles the Deadly Agaric in this condition. When mature the disgusting odour would prevent any one from collecting it.

Fig. 50. Lesser Stinkhorn.
Original.

COMMON STINKHORN (*Phallus impudicus*, Linn.). (Fig. 49.)

This is a somewhat smaller fungus than the preceeding being only 4 to 6 inches high and it lacks the lacy frill or skirt. The cap is distinctly pitted. It does not have quite as pronounced an odour as the Frilled Stinkhorn but still a single plant may be detected five or six rods away. One would scarcely collect it for table purposes.

SMALLER STINKHORN (*Lysurus borealis*, Burt.). (Fig. 50.)

This fungus is only about 2 inches tall. It resembles the Common Stinkhorn very closely but the head is divided into four parts by four white longitudinal ridges. The plant has the same odour as the others only scarcely as pronounced.

There are a few other plants in the stinkhorn group but they may all be detected by the odour.

LYCOPERDACEAE—PUFF BALLS.

The puff balls are very common in woods and grassy places. The fruit body varies in size from half an inch in diameter for the smallest one to 2 feet in the Giant Puff Ball. When young the interior is uniform in composition, white in colour and somewhat cheesy in character. No indication of a cap or stalk can be seen so they can readily be distinguished from the egg stage of the Deadly Agaric and from the Stinkhorns. At maturity the interior of the ball becomes brown and powdery. A slight pressure will cause the spores to puff out in a dense cloud.

Giant Puff Ball (*Lycoperdon giganteum*, Batsch.). Edible. (Fig. 51.)

This fungus sometimes occurs abundantly in pastures and on roadsides in August and September. The fruit body is very large, usually 8 to 15 inches in diameter or even larger. In 1915 a report was received by this Department of six of these puff balls weighing 48 pounds, two just as large and a dozen smaller ones, all found on a piece of ground but 2 rods square. There are reports of these puff balls which were over 3 feet in diameter and weighed 47 pounds.

The fruit body is flattened ball shaped. It is at first pure white and quite smooth. Later it becomes light yellowish brown, and then cracks into many fine areas. When young the interior of the ball is white and cheesy, but when it becomes old it breaks up into a yellowish or snuff-coloured powdery mass.

The puff balls should be gathered while still white inside.

If one succeeds in finding a single one of these balls he is assured of having several mushroom feasts.

Clustered Puff Ball (*Lycoperdon pyriforme*, Schaeff). Edible. (Fig. 52.)

This is a much smaller fungus, the ball being only 1 to 2 inches high. It grows on old timber or on the ground, but the balls occur in great numbers, sometimes forming dense clusters several feet across. The fungus is excellent while still white inside. It is most commonly found in woods from July to October.

Crested or Top-Shaped Puff Ball (*Lycoperdon gemmatum*, Batsch.). Edible (Fig. 53.)

This is one of the smaller puff balls. The fruit body is more or less top-shaped, 1½ to 3 inches high. It grows singly or in small clusters. It is white at first, but become grey to dirty brown in age. The young specimens are ornamented on top with many small points or warts which disappear. Finally the fruit body opens by a round hole in the top and the fine powdery spores are puffed out through this opening. It may be found on the ground in the woods or in open places.

Ornamented Puff Ball (*Lycoperdon pulcherinum*, B. & C.). Edible. (Fig. 54.)

This is one of the smaller puff balls. It is only 1 inch to 2 inches in diameter. It is ornamented on top with numerous pointed scales.

Skull Shaped Puff Balls (*Lycoperdon craniformis*, Schw.). Edible. (Fig. 55.)

This is one of the larger puff balls. It is 6 to 10 inches in diameter and more or less skull shaped. The outer layer of the ball is often cracked or checked into small irregular areas. The colour is generally white but becomes dingy or grey in age. This puff ball differs from the Giant Puff Ball in being smaller

Fig. 51. Giant Puff Ball. Original.
The child is 12 years old and, as can be seen, the puff ball is as large as her body.

Fig. 52. Clustered Puff Ball. Original.

Fig. 53. Crested Puff Ball. Original.

Fig. 54. Ornamented Puff Ball. Original.

Fig. 55. Skull Shaped Puff Ball. Original.

Fig. 56. Earth Star. Original.

and when mature only the upper two-thirds break up to form the powdery mass. The lower third remains behind as a solid base which is slightly hollowed out at the top. It is just as good as the Giant Puff Ball and like it, should be gathered before there is any indication of browning in the interior.

EARTH STAR (*Geaster triplex*, Jung.). (Fig. 56.)

This fungus resembles the puff balls in many respects. When the fruit bodies are young they are ball-shaped and the interior filled with a white cheesy material. Just before they are mature the outer wall becomes separate from the inner part which forms a distinct ball enclosed in an envelope. In this stage they might be mistaken for the young stage of the Deadly Agaric but no distinct cap and stalk are formed. As the fruit body matures the outer envelope splits along several lines and then rolls back so that we have an inner part shaped like a puff ball surrounded by a star-shaped envelope.

The Earth Stars have not been listed as edible.

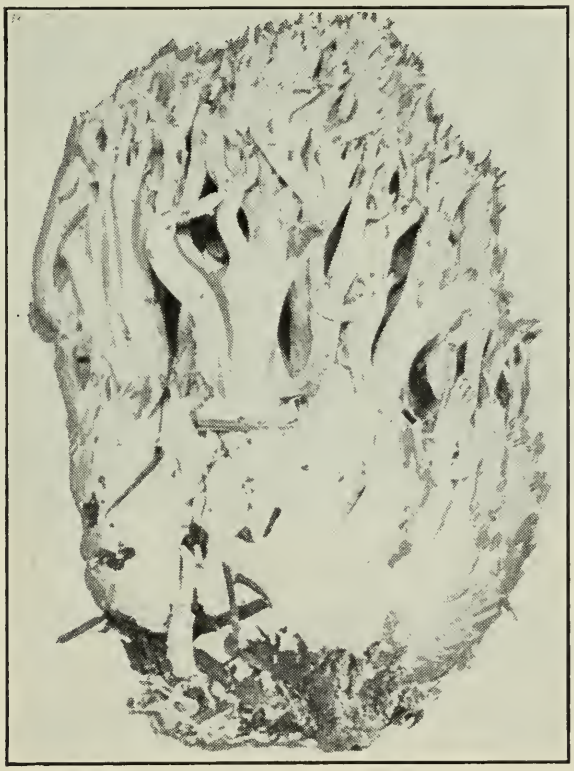

FIG. 57.—Coral Fungus. Edible.
Natural Size (Original).

CORAL FUNGI—(CLAVARIACEAE).

These fungi are upright growing forms growing on wood or on leaves on the forest floor. Most of the species are much branched with ascending branches but one or two forms are simply upright clubs. The Coral Fungi vary in colour from white through yellow to brown, mostly white or yellow. The tips of the branches are often bright coloured. All the Coral Fungi are edible and no one need have any fear in collecting them.

YELLOW CORAL FUNGUS (*Clavaria flava*, Schæff.). EDIBLE. (Fig. 57.)

This fungus occurs commonly in the woods, growing on stumps and rotting logs and is most abundant in warm wet weather in the summer and early autumn. The plant is 3 to 6 inches high and 2 to 4 inches broad. At the base it is thick

and fleshy but the upper half is divided into numerous upright, pale yellow branches. As the plant becomes old it faces to a dingy white. The flesh is firm, white and solid.

Beautiful Coral Fungus (*Clavaria formosa*, Pers.). Edible. (Fig. 58.)

This fungus occurs in the same situations as the preceding but differs from it in being much more branched and having a less prominent base.

Fairy Club (*Clavaria pistillaris*, L.). Edible.

This is one of the unbranched forms and grows up from the forest floor as a simple club-shaped fleshy stalk. The club is usually 2 to 5 inches high and from one-half to 1 inch in diameter at the top. It is firm, fleshy and is slightly acid when grown, but this acidity disappears in cooking.

Fig. 58. Coral Fungus. Original.

HEDGEHOG FUNGI OR TOOTHED FUNGI—HYDNACEAE.

The Toothed Fungi are mainly medium sized to large plants growing on logs, stumps and standing trees. In many cases the fruit body is much branched, bearing many spines or teeth which hang downward. In some cases there is a distinct head with spines on the under side. In colour they vary from white through yellow to brown. None of the forms are poisonous but some are too tough and hard to be edible.

Hedgehog Fungus (*Hydnum erinaceum*, Bull.). Edible. (Fig. 59.)

This fungus is common on logs and stumps in the woods. It forms large white masses 4 to 5 inches across. There is a firm, fleshy base from which are developed short branches bearing slender spines which point downward.

Some other fungi which closely resemble this are the Medusa Head (Hydnum caput medusae) which has the base more branched and still longer spines, and the coral-like hydnum which is branched like the coral fungi.

The Northern Hydnum (*Hydnum septentrionale*, Fr.). (Fig. 60.)

This is a very large fungus often weighing eight to ten pounds. It consists of numerous overlapping shelves which bear spines on the under side. The

fungus generally grows on standing trees and is seen issuing from wounds. It is generally light yellow in colour and is too tough and tasteless to be edible.

CUP FUNGI—PEZIZACEAE.

These fungi produce cup-shaped fruit bodies which vary much in colour; some are white with scarlet interior, some yellow with a golden interior, some light brown throughout. They vary in size from half an inch to 2 inches. Usually the flesh is somewhat gelatinous and becomes slimy when cooked. They are edible but not very good.

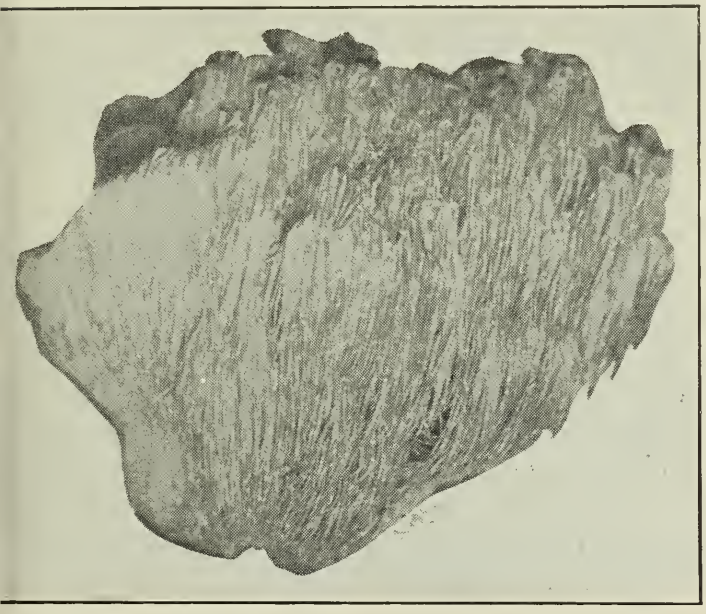

Fig 59.—Hedge Hog Fungus. Edible. Natural Size (Original).

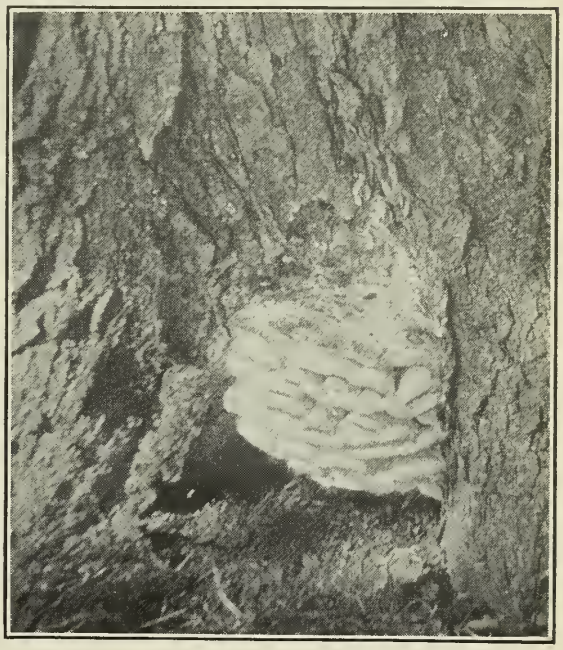

Fig. 60. Northern Hydnum. Original.

Scarlet Cup (*Peziza coccinia*, Jacq.). (Fig. 61.)

This fungus produces a cup which varies from one-half inch to 1 inch in diameter. If the cup arises from a piece of rotting wood buried in the soil it may have a distinct stalk. The stalk and outside of the cup are pure white while the interior of the cup is bright red or scarlet. It is usually one of the common spring fungi.

Fig. 61. Scarlet Cup. Original.

LITERATURE.

Those who are interested in mushrooms can obtain further information on them from the following books:

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Cole.—Guide to Mushrooms.—C. K. Reed, Worcester, Mass.
Marshall, Nina.—The Mushroom Book.—Doubleday, Page Co., New York.
Gibson, W. M. H.—Our Edible Toad Stools and Mushrooms.—Harper Bros., New York.
Massee, Geo.—British Fungi.—E. P. Dutton & Co., New York; Routledge & Sons, London.
Murrill, W. A.—Agaricales, North American Flora, Vols. 9 and 10.—New York Botanical Gardens, N.Y.
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Peck, C. H.—Mushrooms and Their Uses.—Cambridge Botanical Supply Company, Cambridge, Mass.

GROWING MUSHROOMS.

In some countries mushroom growing is a considerable industry. Where the industry is firmly established advantage is taken of locations where temperature and moisture can be easily and cheaply controlled. The catacombs and other underground passages under Paris are utilized. In some sections natural caves are used. In some places in the United States abandoned coal mines make ideal situations for mushroom growing. Where such places are lacking special mushroom houses are built. Many people would like to grow mushrooms for home use or for a small local market. For such limited production elaborate mushroom houses are not necessary. Mushrooms may be grown any place where conditions of temperature and moisture are favourable. A shed, cellar, cave or a vacant space in the greenhouse may be utilized to advantage for this purpose. The most essential factor, perhaps, is that of temperature.

Temperature.

The most essential factor in growing mushrooms is, apparently, the temperature. In order to produce a good crop of mushrooms the temperature must be controlled within narrow limits, high temperature being especially injurious as diseases then develop. Low temperatures simply delay growth. For profitable production the temperature should not be lower than 50° Fahrenheit, nor higher than 65°. The proper temperature ranges from 53° to 60° with the most favourable temperature 55° to 58°. Any severe change in temperature will retard the growth or may do more serious harm, even destroying the crop. In moist mushroom houses or in caves rots and moulds develop very quickly at temperatures above 60°. Out doors it is very difficult to control conditions. In Canada, periods of very hot, dry weather alternate with cold wet weather so that conditions for mushroom growing outdoors are not at all favourable.

Moisture.

The moisture factor is next in importance. With an atmosphere saturated with moisture, and with water dripping from the walls, a very poor crop can be expected. On the other hand, if the air is too dry the beds cannot be kept

sufficiently moist. The air should be kept fairly moist, about 60 to 75 per cent saturation, so that there will be a gradual evaporation from the beds.

The beds should be kept fairly moist but not wet. They should never be drenched with water but should be gently sprinkled. It is impossible to say how much water should be applied. Where the room is dry the beds may require sprinkling twice a day. In a cellar or cave they may not require watering oftener than once a week.

Light.

Mushrooms do not require light for their development. On the other hand light is not necessarily detrimental. Sunlight is accompanied by heat and it is generally more difficult to control temperature and moisture in a lighted room. The air in a lighted room tends to become hotter and drier during the day and cooler and damper at night. If the temperature and moisture can be controlled the light will do no harm. It is usually easier to keep temperature and moisture uniform in a cave or cellar than in a barn or greenhouse.

Material to Use in Growing Mushrooms.

The best material upon which to grow mushrooms is a compost made from horse manure. The manure should contain considerable straw, but not too much long, coarse material. The best material will be quite damp, containing a large amount of urine. Manure containing shavings or sawdust is not so good. Garden refuse should not be used. Manure from veterinary hospitals should be discarded as it contains quantities of disinfectants which will prevent the growth of the mushrooms. Under the present conditions street sweepings cannot be used as they contain too much oil.

The quantity of manure required.—A grower should be able to calculate fairly accurately the quantity of manure required for beds of any size. A car load of manure, about twelve or fourteen large wagon loads, *i.e.*, twenty four to thirty tons, will make a bed of about 3,000 square feet. A small wagon load, say a ton, will make a bed of about 100 square feet. This quantity will vary with the quality. Manure containing much straw or coarse material will need to be shaken out and the coarse material removed, so will make smaller beds.

Preparing the Compost.

The fresh manure should be well shaken to rid it of coarse straw and to mix it thoroughly. It should then be placed in a pile about three feet deep and kept moist and allowed to heat or ferment, taking care that it does not get so hot and dry as to burn—that is to get white and dry inside. To prevent burning the pile should be forked over every three or four days and watered if necessary. The manure should feel damp to the hand but should not drip water when squeezed or pressed. It is best to keep the pile under cover so that it will not be leached by rain. Furthermore, it should not be allowed to freeze. The best time to ferment the manure is September or October.

While fermenting, the manure will attain a temperature of 100° to 150° Fahrenheit, but after a week should begin to become gradually cooler, and when it has cooled down to 70° will be ready to use. If the fermentation is thoroughly done the manure will by this time have lost all objectionable odour; will have an odour suggesting mushrooms; will have a slightly greasy feel and the straw will have a uniform dark brown colour and the droppings will appear as brown powder.

Making the Beds.

For growing mushrooms in small quantities beds may be made directly on a cellar floor or under the greenhouse benches. The boxes a foot deep and as large as desired may be made with sides of board or plank, a bottom is not necessary.

Place in the bottom of the box four or five inches of manure and pack it down tightly. Then add two inches of rich garden soil. Pack down. Add another layer of manure and another of soil and continue until the box is full, taking care to keep the compost firmly packed.

A very simple method of preparing the beds is as follows: Mix thoroughly the manure with good garden soil, using three bushels of manure to one bushel of soil. Place the compost in the boxes prepared and pack firmly by tamping with a brick.

After the beds are prepared they will probably heat to some extent but will again cool. After the temperature has cooled down to 70° they may be planted.

Planting or Spawning.

We have not yet been successful in growing mushrooms from spores. In planting mushrooms we use spawn.

What Spawn Is.

Spawn is dry compost containing the mycelium of mushrooms. There are two forms of spawn, brick spawn, in which the compost is compressed into blocks 8½ inches by 5½ inches by 1 to 1½ inches, and flake spawn, in which the compost is in the form of loose masses. Brick spawn generally comes from England or the United States, while flake spawn comes from France. It is generally conceded that brick spawn is the best, as it does not dry out and deteriorate to such a great extent as does flake spawn.

Mushroom spawn can generally be obtained from any of the larger seed firms. After the bed has cooled down to 70°, the spawn may be planted.

The bricks are broken into pieces about 2 inches square. A hole about 2 inches deep is then made in the bed and a piece of the spawn pressed firmly down, then thoroughly covered with the compost which is then firmly packed. A piece of spawn should be planted to every square foot of the bed. Now cover the bed with about 4 inches of clean straw and, if convenient, with a piece of old carpet.

After ten or twelve days the bed should be examined. By this time the spawn should have begun to grow, forming fine white threads all through the bed. The straw should be removed and a layer of garden soil 1 or 2 inches thick should be added to the bed and firmly but gently packed down. Then replace the straw and carpet.

Care should be taken to keep the bed moist but not too wet. It is better to apply water with a watering pot every few days rather than drench the bed with a hose or buckets of water.

After about forty days mushrooms should begin to appear and the straw and carpet should then be removed. The bed should continue to bear for three months or more, giving successive crops of mushrooms every few days. A pound to the square foot is a good yield, although two pounds may sometimes be obtained.

When no more mushrooms appear the bed should be thoroughly cleaned out, all the compost being removed. It will also be well to scrub the bed thoroughly with formalin before attempting to grow mushrooms again. The

compost cannot be used again for growing mushrooms, but it will make excellent fertilizer for the garden, and is also very good for potting plants.

Gathering the Mushrooms.

It is best to gather the mushrooms just before the veil breaks. They are then as heavy as they will become. If left until the veil breaks they begin to lose weight and also the gills rapidly become brown and when cooked do not present the best appearance, as well as giving the liquor a brown colour.

When the mushrooms appear singly or in small clusters the best way to gather them is as follows: Take hold of the stalk just under the cap and give the mushroom a slight twist. This will break it loose from the spawn and it can then be lifted up without disturbing the bed. The compost should be pressed firmly into the cavity formed. The soiled end of the stalk should be cut off and discarded, but not allowed to remain on the bed.

If the mushrooms come up in large clusters, the clusters should be cut off close to the soil and placed in a receptacle. The stubs of the stalks should then be carefully removed and the cavity formed filled in with compost.

The foregoing account of mushroom growing applies particularly to growing them in small quantities for the home or limited local use. There are a number of good books and bulletins which can be secured, dealing with mushroom growing on a commercial scale.

Literature on Growing Mushrooms.

Atkinson, Geo. F., and Shore, R.—Mushroom Growing for Amateurs.—N.Y. Coll. Agr. Bull. 227.
Duggar, B. M.—The Cultivation of Mushrooms.—U.S. Dept. of Agr., Farmers' Bulletin No. 204.
Duggar, B. M.—The Principles of Mushroom Growing and Spawn Making.—U.S. Dept. Agric. Bur. Pl., Ind., Bull. 85.
Falconer, W.—Mushrooms, How to Grow Them.—Orange Judd Co., New York.
Duggar, B. M.—Mushroom Growing.—Orange Judd Co., New York.
Jackson.—Secrets of Mushroom Growing.—3267 Northwestern Avenue, Chicago, Ill.
American Spawn Co.—Mushroom Culture.—St. Paul, Minn.
The Cultivated Mushroom.—Bureau of Mushroom Industry, Chicago, Ill.

Most Seed Companies supply pamphlets on Mushroom Growing.

RECIPES FOR USING MUSHROOMS.

1. To Can Mushrooms.

Sometimes more mushrooms are gathered at one time than can be used immediately. These cannot be kept like vegetables, but may be preserved by canning.

Peel, dry, wash thoroughly and boil in well-salted water until done. The very tender kinds, such as ink caps, require little boiling. The tougher kinds may be boiled for an hour. Morels and puff balls should be cut into small pieces. Be sure to salt abundantly and have boiling hot when put into the glass jars, then seal as for any canned fruit or vegetable.—*Benedict.*

2. Mushrooms May be Dried.

Take those neither very young nor very old. Remove the butts. Then slice and string or skewer lightly and expose to a current of warm, dry air. A warm oven with the door open is a good place. When quite dry and shrivelled,

pack in tins with spice at the top and bottom. When wanted for use soak in tepid water for some hours, then cook.—*Hay.*

3. Soup.

One quart mushrooms
Three pints water
Half pint milk
One tablespoon flour
Two tablespoons butter
One dessertspoon salt
One teaspoon pepper

Carefully clean the mushrooms. Put in a covered boiler with water, and boil slowly for an hour. Put through a colander. Reject that which does not pass through. Add milk thickened with flour, butter, salt and pepper. Bring to a boil. Serve. This makes two quarts of soup.—*McIlvaine.*

4. Stewed Mushrooms.

Cut into small pieces of even size, place in a covered saucepan. To each pint add two tablespoons of butter. There will be enough water from washing to make liquor. Stew slowly twenty minutes; season to taste with pepper and salt. May be served either alone or on toast.

The tougher kinds should be soaked in warm water half an hour before stewing. Parsley, nutmeg or beef gravy may be added.

5. Fried Mushrooms.

One pint mushroom caps
One teaspoon salt
Half teaspoon black pepper
Two tablespoons butter

Put the mushrooms into boiling hot butter and fry for ten minutes. Add a little milk or cream thickened with flour. May be served alone or on toast.

6. Baked Mushrooms.

Wash, place the caps in a tightly-covered dish or pan, after dipping them in bread crumbs. Arrange in layers with a small piece of butter on each mushroom. with a little pepper and salt. Bake from twenty to forty minutes until done. Serve on toast. Cheese grated on each layer makes a desirable addition.—*McIlvaine.*

7. Scalloped Mushrooms.

Put in a baking dish layers of cold cooked meat, diced or sliced. (Stewed until tender.) Moisten with gravy or sauce. Alternate with stewed mushrooms. Cover with buttered biscuit or bread crumbs. Bake about twenty minutes.

8. Salads.

Many kinds of mushrooms make good salads. The shaggy mane, ink cap and many of the coral fungi are good raw. The tougher kinds should be first stewed, then drained and cooled.

Mix with mayonnaise dressing or make a dressing to taste of oil, vinegar, salt and pepper. Serve on lettuce.

9. Fresh Mushroom Sauce.

Two tablespoons butter
Two cups freshly prepared mushrooms
Salt and pepper

Put butter in a granite or porcelain-lined saucepan. When hot add mushrooms. Cover closely and cook briskly two or three minutes. Season to taste with salt and pepper, and serve with broiled beefsteak, birds or sweetbreads. —*Mr. E. B. Irving.*

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POISONOUS MUSHROOMS DESCRIBED IN THIS BULLETIN.

* Amanita frostiana
* Amanita muscaria
* Amanita phalloides
* Amanita verna
† Boletus felleus
† Boletus luridus
† Boletus piperatus
† Clitocybe illudens
‡ Cortinarius cœrulescens
‡ Dictyaphora duplicata
‡ Entoloma grande
‡ Entoloma graveolens
‡ Lactarius torminosus
‡ Lysurus borealis
‡ Paneolus papillionaceus
‡ Phallus impudicus
† Russula emetica
– Russula virescens

* Deadly poisonous.
† Violently poisonous, but not deadly.
‡ Mildly poisonous and very unpleasant.
—Doubtful.

Ontario Department of Agriculture

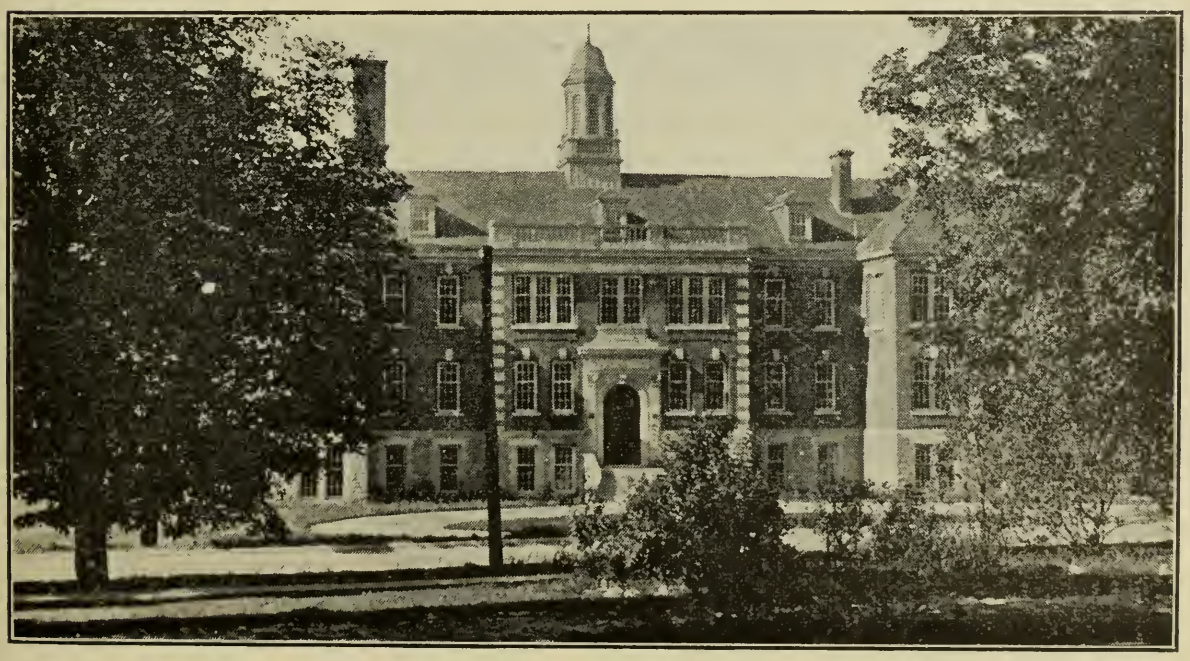
ONTARIO VETERINARY COLLEGE

BULLETIN 304

INFECTIOUS ABORTION OF CATTLE

By

C. D. McGilvray, M.D.V., D.V.Sc.



Ontario Veterinary College, Guelph, Canada.

TORONTO, ONTARIO, FEBRUARY, 1924

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BULLETIN 304] [FEBRUARY, 1924

Ontario Department of Agriculture

ONTARIO VETERINARY COLLEGE

INFECTIOUS ABORTION OF CATTLE

By C. D. McGilvray
Principal, Ontario Veterinary College
Guelph, Canada.

FOREWORD

This bulletin has been prepared to meet a popular demand, and to furnish such information regarding Infectious Abortion of Cattle as may seem justified at the present time. It is hoped that it may prove useful to owners of breeding cattle as well as to veterinary surgeons. In its preparation the use of technical terms has been avoided as far as possible, and there is a repetition of some statements in order to emphasize their exact meaning. Articles on abortion by various authorities have been freely consulted and drawn upon, of which due acknowledgment is hereby made. Among the writings referred to are those of McFadyean and Stockman of Great Britain; Williams, Mohler, Eichhorn, Schroeder, Giltner, Hart and Traum of the United States.

Nature and Occurrence of the Disease

The condition generally known as abortion or "slinking the calf" is one which is often encountered among pregnant cattle in a herd. Its occurrence is steadily increasing, and is becoming more acutely felt by many breeders, by noticeably lessening the breeding efficiency and productiveness of their herds. It has commonly been ascribed to result from a variety of causes, and many explanations have been offered, such as accidents and injuries of all kinds, mineral deficiencies, errors in feeding and watering, influences of the weather, and also supposed defects in the parents. While abortion may result in some cases from such causes, nevertheless they actually account for only a small number of the cases in cattle, the larger percentage resulting from a Communicable Disease which is termed Infectious or Contagious Abortion.

What is the Cause of the Disease?

This disease is essentially an infectious malady of cattle, which is manifested by the premature expulsion of the fetus, or untimely birth of the calf associated in many cases with retained after-birth, and sterility, owing to an infectious catarrh set up in the womb. The prevailing cause of this has been shown to be due, to invasion of the system of the affected animal by microorganisms, or disease germs, of which the best known is the *Bacillus abortus* or Bang's Bacillus of Cattle Abortion. Occasionally other organisms may cause abortion, namely, the *Bacillus pyogenes* and the *Vibrio fetus*.

How Does the Disease Usually Get into a Herd?

The exact time and manner in which cattle contract, and spread the disease, or infect each other is not always an easy matter to correctly establish. The disease is generally first introduced into a clean herd through unknowingly obtaining breeding cattle from an affected herd. These carriers of infection from one herd to another, are usually either open, or pregnant females already infected which become dangerous spreaders of the disease germs, especially through the discharges from the genital passage. Occasionally infection is introduced by an infected bull, and is spread by the discharges escaping from the sheath at certain times. It is important, that breeders should know the places in the body, where the abortion germs may locate, and to understand how the germs of the disease may leave the body of an infected animal and gain access to the body of some other animal and infect it.

The Location of the Abortion Germs in the Body

It is now pretty well known, that the germs of abortion disease in cattle, select certain places in the body where they locate themselves.

The udder and supramammary lymph glands are frequent places of refuge for the germs in the case of mature milking cows. It has been definitely proved that the germs can remain in the udder of infected cows and be given off in the milk for a year or longer.

The pregnant womb. It is a well known fact, that the disease germs causing abortion, show a decided tendency to locate in the pregnant womb of infected cattle.

The genital discharges. The germs are frequently present in the discharges from the genital passage immediately before, and for several weeks following an abortion.

The genital tract of the bull has also been found to be one of the places, where abortion germs may be present. In the case of an infected bull, the germs locate in the genital apparatus and may develop an abscess, from which the germs may be expelled at times as a discharge from the sheath.

The alimentary tract of calves, also serves as a place of habitation for the germs, during such periods of time as they are receiving infected milk. In such cases the germs are present in the stomach and intestines of calves. It has not, however, been definitely established that the infection continues in the system of calves after they are weaned and not receiving infected milk.

How is the Infection Spread in a Herd?

By infected cows. If an infected cow is introduced into a previously clean herd, she will sooner or later infect some of the other females on the premises. This may take place quite readily either in the stable or at pasture. If an animal aborts while on pasture the grass becomes contaminated by the vaginal discharges. If the animal aborts in the stable, the after-birth and discharges contaminate the stalls and gutters as well as the bedding and litter. The throwing of the after-birth, contaminated litter and bedding from the stable to outside yards affords cattle the opportunity of devouring same. It is a common habit of cattle to eat contaminated hay and straw when it is thrown outside in the yards, or on top of manure heaps. The after-birth and discharges from the aborting cow must always be regarded as dangerous carriers of the germs, and all contaminated bedding and litter should be safely disposed of to prevent the spread of infection. The milk from infected cows is also liable to spread infection if spilled on the feed or bedding.

By infected bulls. In the case of the bull, the chief danger of spreading infection is through the discharges from the sheath contaminating the bedding and litter in the stable or the grass in pastures, in the same manner as the discharges from an aborting cow. The bull is not considered to spread the disease to any great extent directly through copulation (service connection) with the female.

By infected calves. During the time calves are being fed on milk from infected cows they may be expelling the germs with their feces (manure), thus contaminating their surroundings.

How Does the Infection Enter the System of an Animal?

It has been established that the infection enters the system most frequently by the mouth with infected feed, water and milk, and finally locates in the pregnant womb and udder. This is known as infection by ingestion, through the introduction of contaminated food and water into the digestive tract. The explanation of this is that an infective discharge, containing great numbers of the bacilli or abortion disease germs is frequently expelled from the womb and genital passage of affected cows. The infective discharges, on being expelled, are very liable to soil the bedding and fodder, such as straw, hay, pasture grass and water, which in turn are taken into the mouth and consumed by other pregnant cows. The germs of the disease, being thus taken into the mouth with the feed and water, are swallowed, and pass into the stomach and bowels, from which they are absorbed, and are then carried by the blood or lymph, throughout the system until they reach and locate themselves in the pregnant womb and udder, which are their favourable places of abode. In some cases, the germs may primarily locate in the udder and lymph glands, where they remain stationary for a variable period, and subsequently proceed to the womb when the animal becomes pregnant. In the meantime the germs would be given off in the milk, causing it to be infective for calves if fed to them, resulting in their intestinal discharges becoming a source of contamination to females of breeding age. For a time it was thought calves contracting infection through milk, would grow up infected, but this belief has not been sufficiently corroborated. It is claimed, by several authorities, that in the case of calves the infection leaves their system when they are weaned, and that they become reinfected during subsequent pregnancies to cause them to abort. The infection

may also be taken into the system, by one cow licking the vaginal discharges of another cow which has aborted. With regard to infection entering the system by means of the genital passage, this was at one time thought to be the essential portal of entrance. It was believed, that the discharges from aborting cows dropping in the stable gutters and stalls, infected others by direct contamination of the genitals while they were lying down, or through being switched by the tails of infected cows against the genitals of other pregnant cows occupying adjacent stalls. While this seems plausible, it is doubtful if infection very often enters the system directly through the genital passage from the outside. It was also contended; that the infection was chiefly conveyed from female to female through the medium of the bull during service. It is doubtful if the bull does to any great extent actually transmit infection directly through the act of copulation or service. In the case of the bull, he chiefly acts, as a spreader of infection, through the medium of urethral discharges from the sheath contaminating his surroundings as previously mentioned. While due regard and consideration must always be given to each and every factor as likely means of conveying the disease, it must always be kept in mind that, "*infection takes place chiefly through the avenue of the mouth into the system by ingesting bedding, food, water and milk contaminated with infected discharges from aborting cows, the urethral discharges of infected bulls, and the fecal discharges of infected calves.*"

How Do the Germs Cause Abortion?

Irrespective of the manner by means of which the germs may have entered the body, they show a decided preference to attack the womb during pregnancy. Upon their reaching the womb of pregnant cattle, they begin to operate harmfully by giving rise to a catarrhal condition of its surface, and also of the contacting fetal membrane, causing a gradual destruction of the placenta, which forms the nutritive medium of connection between the mother and the fetus. The disturbance of this nutritive connection frequently results in causing the death of the fetus, and its premature expulsion from the womb, which constitutes the act we term abortion.

At What Stage of Pregnancy May Abortion Occur?

The stage of pregnancy at which the act of abortion takes place is variable, so that it may occur at any time. Under natural conditions the course of the disease is as a rule slow, and the majority of cases seem to be noticed between the fourth and seventh months of pregnancy. At the same time it sometimes occurs earlier and sometimes later. To some extent it depends on the time the animal becomes infected, and the degree of infection. A massive infection of the system with virulent germs soon after conception may cause an early abortion, while slight infections might take longer, resulting in the calf being carried almost full time. Some animals also show a greater susceptibility than others.

What Are the Premonitory Signs?

Abortion may take place without any decided symptoms of its approach, and the animal may appear quite well up to the time when the fetus is being expelled. In fact, the abortion may entirely escape notice if it occurs during the early stages of pregnancy, as the embryo or small fetus and the membranes are easily expelled, and the owner's suspicions are only aroused when he finds certain of the cows or heifers, considered safely in calf, to be again in season.

Even when the fetus is fairly well developed during the advanced stages of pregnancy, it may be expelled without notice, during the night for example, or out in the field, so that the accident is first discovered by the presence of the aborted calf and the after-birth behind the cow. In other cases, indications of its probable approach are manifested by the animal, and a succession of troubles follow in the herd which signify the existence of the disease.

The Udder.—It is claimed that the udder in many cases furnishes one of the most reliable signs of impending abortion in milking cows. In these cases it has been observed that in affected milking cows, for some time before they abort, the udder does not shrink up, collapse, or get flabby after being milked as is ordinarily the case. Instead, the udder remains more or less turgid, and a slightly edematous or dropsical condition of its surface also takes place. In the case of pregnant heifers, and "dry" cows, the udder may become prematurely enlarged, and full, denoting the appearance commonly termed "making a bag early."

The External Genitals.—In some cases for a few days prior to the act of abortion, there may be noticed a slight vaginal discharge, and the vulva appears relaxed. Later, the vulva appears swollen, and coming from it may be noticed a brownish-coloured sticky discharge. There may also be present the usual manifestations of impending expulsion of the fetus, such as straining. Finally, the water bag protrudes from the vulva, followed by the projection of the fetus.

Retention of the After-birth.—It has been noticed in a large number of cases of cattle abortion, that after expulsion of the calf the after-birth is retained, or, as commonly expressed, the cow fails to clean. Even when the after-birth is not retained, a brownish discharge heavily laden with the disease germs, may continue to come from the genital passage for several weeks following parturition. So frequently does retention of the after-birth and this discharge occur in contagious abortion, that they are considered as being significant of the disease in a herd, even when the calves are carried the full time.

What Are the General Effects in the Herd?

The usual experience in outbreaks of contagious abortion is, that during the first two or three years of its appearance in a herd it claims many victims, and then becomes reduced to a smaller number of cases occurring each year, unless many new females are introduced or young heifers are growing up, which in turn become attacked. It has also been observed that occasionally the calves, while born at normal time, arrive weak and puny, and sometimes become affected with white scours and pneumonia, causing many deaths if not checked. The disease is in some respects self-limiting, as aborters seem after a time to develop within themselves some protection. As a result, amongst infected cows a considerable percentage abort once or twice in succession, and a certain number three times, after which they appear to acquire a degree of immunity, or resistance to the disease, which enables them to reach the normal period of calving. This feature has apparently led some to volunteer the statement that the disease will disappear of its own accord, or run itself out of a herd in the course of three or four years, provided no freshly infected cows are introduced. This belief is, however, not altogether correct, because, even when no freshly-infected cows are introduced, the tendency is for the disease to prevail and attack the young breeding females in the herd, unless special measures are taken to protect them. What actually takes place is, that the number of abortions become somewhat

less, and not so alarming, in that the percentage among previous aborters is reduced, if the herd is kept intact. At the same time many of the cows may retain the after-birth and sterility may increase in the herd, reducing its breeding efficiency.

Is There Any Connection Between Abortion and Sterility?

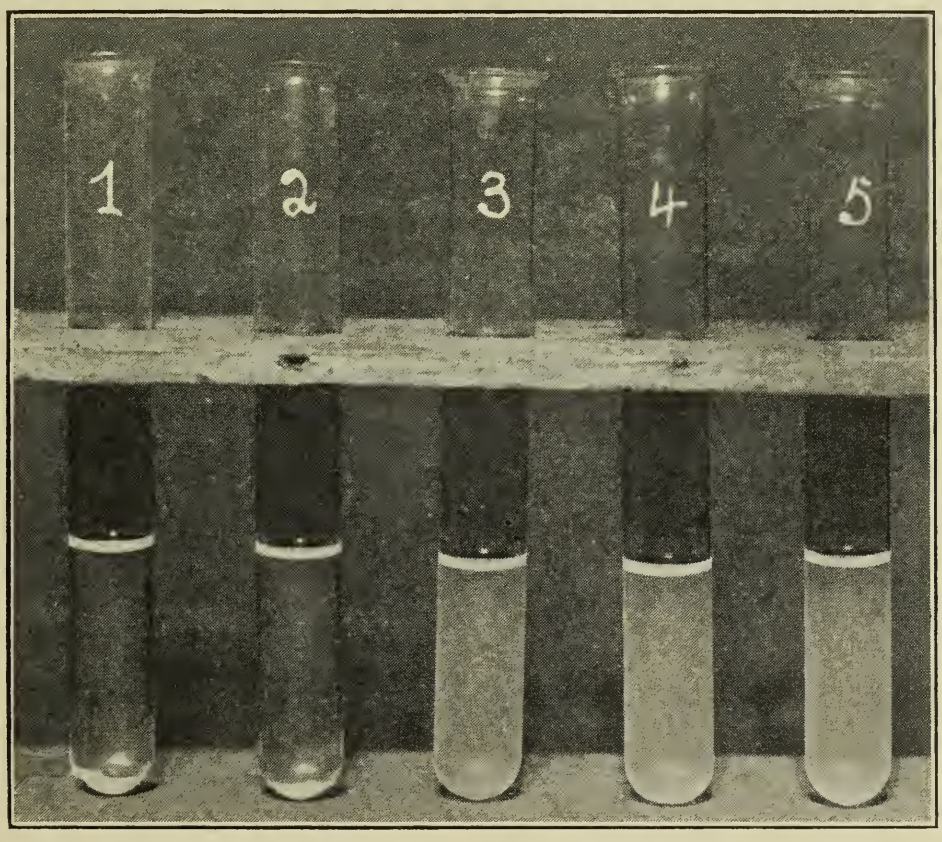
There is a close connection between abortion and sterility in many cases. It has been noticed where there is abortion disease in a herd, that sterility or barrenness thereafter prevails among both cows and heifers, so that the number of "shy breeders" increases in the herd. This phase of abortion disease seriously reduces the breeding efficiency, and lessens the productiveness, of many herds. The cause of sterility in these cases is a resulting diseased condition of the womb, oviducts, and ovaries. The diseased condition of the womb and oviducts is often the result of the catarrhal inflammation set up by the existing infection, and also owing to retention of the after-birth, which is often the case in abortion. In the case of the ovaries, they may undergo cystic degeneration, there may be retained corpus luteum present, or the so-called brownish bodies persisting in the ovaries. Either of these conditions will prevent ovulation and conception. Cows with cystic ovaries sometimes become nymphomaniacs (chronic bullers). In some cases the womb becomes filled with pus, and estrum may be indefinitely postponed, causing one to think for a time that the animal is pregnant, until finally the true condition is detected, and the animal is found to be sterile. In old standing cases of sterility the appearance of the animal changes, in that the rump becomes altered in form, with the "tail head" appearing unusually high and peaked, with hollows on each side, and the back over the loins is depressed.

How Can the Disease Be Detected?

The importance of being able, if possible, to detect and recognize the disease when it first occurs in a herd is apparent, so that immediate steps may be taken to arrest its progress as far as possible. In this regard, the safest course to pursue is to accept the fact of any cow aborting on premises formerly exempt, as a sufficient reason for suspecting that the disease is present, and particularly where new females have been added to the herd during the year. It is not necessary that the new females introduced into the herd should be the first to abort, or even to abort, as they may be what are known as immune carriers of infection. That is to say, they may have acquired a degree of immunity or self-protection, which enables them to safely carry the calf full time, but for a time before calving, and for a time thereafter, they are capable of spreading infection to others, by means of their vaginal discharges containing the disease germs, or by their milk containing the disease germs. Additional cases of "calf-slinking" occurring at intervals in the herd should be considered confirmatory evidence of infectious abortion being present. Research experiments and investigations have been made, with the view of devising some satisfactory method of test, capable of determining the presence of latent infection in cattle pregnant or otherwise. The most reliable methods used for this purpose are special blood tests, one of which is known as the agglutination test. Whenever any grounds for suspicion exist, arrangements should immediately be made to have the blood of the animals tested.

What is the Agglutination Test?

This is a test made of the blood samples taken from suspected cattle. The test is of a somewhat delicate nature, which can only be properly performed in a suitable laboratory equipped for the purpose. In making this test the blood serum of the suspected animal is placed in test tubes and has added to it a culture suspension of the *Bacillus abortus* or abortion germs. The bringing into contact of the blood serum with the culture suspension may cause a change to take place in the test tube which is known as the reaction. The results are based upon the specific action which the blood serum has upon the suspension, which in the case of an infected animal would cause the abortion bacilli to



The Results of the Agglutination Test.

In test tubes 1 and 2 a positive reaction is present showing the clumping of the bacilli at the bottom of the tube in the form of a white deposit. This is what takes place in the case of blood taken from an infected animal. In test tubes 3, 4 and 5 the contents of the tubes remain unchanged as a uniformly turbid suspension, indicating that no reaction has taken place in the case of blood taken from healthy animals.

become agglutinated (clumped together) in the bottom of the test tube, indicating a positive reaction. If the blood serum being tested was obtained from an animal not infected, the contents of the test tube would remain unchanged in appearance, indicating no reaction.

What Information Will the Agglutination Test Furnish?

This test will furnish valuable information as to whether or not the animals from which the blood is taken have been infected with the *Bacillus abortus*. If all the animals in a herd are tested, the results will show to what extent the herd is

affected with contagious abortion. The test will not, however, tell whether each individual animal has already aborted, or when it will abort, or, if it has aborted, whether it will abort again.

What Value Has the Testing of the Blood?

A definite reaction of the blood serum to the agglutination test indicates that the animal from which the blood has been taken is, or has been, infected with the germs of infectious abortion. For reliable results samples of blood should be examined from the whole herd, to determine the extent of the infection in the herd. In the case of animals being purchased to be added to a clean herd they should be tested, and if they react to the test they should not be allowed to enter the herd. As a rule, animals which give a positive reaction to the test are the ones most likely to abort. At the same time some of them do not abort, because they may have acquired a certain degree of immunity to protect themselves which enables them to calve normally. Nevertheless, these same individuals may be what are termed immune carriers, and may be spreaders of infection to others, unless precautions are taken to prevent them doing so. Again, some animals may give a negative reaction, and subsequently abort on account of becoming infected at a later date. Occasionally some animals will give a negative reaction shortly after having aborted, owing to their blood not being in a suitable condition, so that it is always better to wait for at least ten days after an animal aborts before testing its blood. The test may also be found less reliable in the case of animals which have been treated with abortion vaccines. It is important to realize these vagaries and limitations, and not to expect unreasonable assurances, which are impossible from the test. In spite of everything, the testing of the blood when properly performed is trustworthy, and of great value for the detection of latent infection in female cattle, both before and after aborting, and in bulls, which enables the adoption of measures to safeguard reactors from spreading infection to others.

How to Obtain Blood from an Animal to be Tested

As a rule an owner will find it to his advantage to get his veterinary surgeon to take the blood from the animals. A sufficient amount of blood can be obtained from either the jugular vein, the vein of the ear, or the vein of the tail. Of the three places, the jugular vein is preferable. To withdraw the blood from the vein a sharp large-sized hypodermic needle is used. The needle should be carefully cleaned and boiled each time before use. Care must also be exercised to keep the lumen of the needle open as it may get clogged with blood clots. This can be readily overcome by inserting a clean wire stillette into the lumen of the needle each time it gets blocked. In order to facilitate the introduction of the needle into the vein, the jugular groove on the side of the neck is pressed upon firmly with the thumb so as to cause the jugular vein to distend, by retarding the blood in it. The needle is then inserted into the centre of the engorged vein. If the hair is long it should be clipped, and the skin disinfected with a two per cent. solution of lysol, or with a solution of tincture of iodine, or any other suitable disinfectant. Another method of distending the jugular vein is by tying a cord firmly around the neck at its lower part. It is essential that the blood be obtained in a clean manner to prevent contamination. Once the needle is inserted in the vein, the blood will flow freely from the end of the needle, and should be collected in a small vial or bottle. It is important that the vials or bottles used to hold the blood are clean, and perfectly dry, as the

presence of moisture may cause the blood to precipitate, which interferes with the test results. One ounce of blood (two tablespoonsful) is sufficient to take from each animal. The blood should be allowed to flow directly from the needle into the small bottles. The bottles should be filled up to the neck and firmly corked. They should be allowed to stand until the blood has clotted, and the serum has separated, as it is the serum which is used in making the test. Each bottle should then be properly numbered on the cork, and labelled, giving information to enable a correct identification of the blood belonging to each animal. A duplicate of these particulars should be retained by the sender for his own guidance. The bottles should then be carefully packed in a small box, and immediately sent to the laboratory.

How and Where to Send Blood Samples to be Tested

Blood tests for the detection of abortion can be obtained for residents of Ontario by sending blood samples to the laboratories of the Ontario Veterinary College at Guelph. The blood samples should be properly packed in a suitable container to prevent breakage, and sent either by mail, or by express prepaid. There should also be placed inside of the wrapper a slip of paper containing the name and address of the sender, and particulars regarding the samples. On the outside the package should be plainly addressed to the Ontario Veterinary College, Guelph, Ontario, accompanied by the name and address of the sender. On receipt of the blood samples at the College, they will be carefully submitted to the agglutination test, and a report of the results will, in the course of a few days, be mailed to the sender. No charge will be made by the College for making the tests for residents of Ontario.

What are the Best-Known Methods of Prevention and Treatment?

In this regard one can only proceed intelligently in accordance with established principles and facts, and to be guided in the future by further discoveries through research and investigation. Towards this end, a clear conception of abortion disease is necessary as regards its nature and cause, how it can get into a herd, how it spreads, how the germs leave the body of an infected animal, how the germs enter and infect the body of another animal, the effects and signs of the disease, and how it may be detected. These phases have all been already described and should be carefully studied. No permanent progress can be made in the interests of breeders by attempts which are made from time to time, to disparage the reputable veterinarian, through his refusal to recognize the persistent efforts of some enterprising persons to exploit commercially some unknown remedy or so-called treatment as an alleged cure for abortion disease. They are invariably quack preparations of no real value for the purpose intended, and are placed on the market solely for personal gain and profit. There is no longer any recognition in medical science for secret alleged cures, because honourable ethics require the true nature of all cures being made known, *for the good of all, and the reward lies in the benefit conferred to mankind through so doing.* Therefore they are not recommended in this bulletin, and for the additional reason that, *there is a growing sentiment among breeders against being further exploited in this manner.* Broadly speaking, the matter of prevention and treatment is concerned with two procedures, namely, *the prevention of healthy herds becoming infected,* and *the treatment of infected herds to suppress the disease.* Under the existing conditions they both present vexatious

difficulties to the veterinarian and the breeder, which can only be overcome by confidence in each other, by close co-operation, and by earnest, persistent efforts along proper lines. Up to the present, the essential basis of dealing with infec-

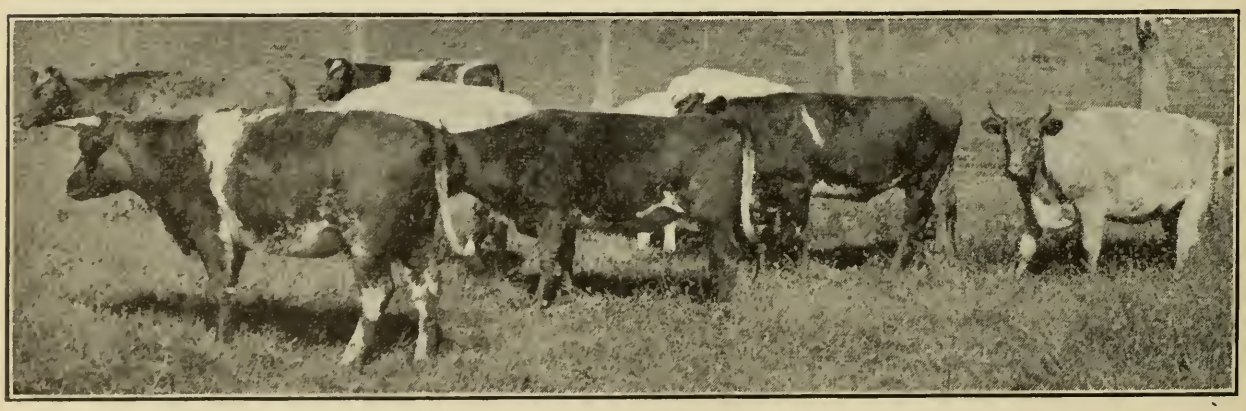
A clean herd always shows a good percentage of calves and should be protected from becoming infected.

tious abortion in cattle is by precautionary measures, the testing of suspected animals, methods of sanitation and isolation, methods of sexual hygiene supplemented by the judicious use of vaccines. These methods will be carefully explained under different headings.

What Precautionary Measures are Required to Protect a Clean Herd?

To protect a clean herd from becoming infected, precautions must be taken to prevent infected cows from mingling with healthy ones. Suspected animals should be kept isolated until a test of their blood has been made. If the test results indicate a positive reaction, the animal should not be admitted into a clean herd. As already stated, the disease is generally introduced into a clean herd through obtaining adult breeding cattle from an affected herd. Before purchasing breeding cattle, careful enquiries should be made to ascertain if the herd from which they are being obtained is affected. One can sometimes gain a fair idea of this by checking up the number of calves and yearlings with the number of females of breeding age.

As the basis of an honourable transaction between breeders the buyer has a moral right to receive from the seller a frank answer as to the existence or



Too many cows and heifers of breeding age in a herd without a corresponding number of calves should be regarded with suspicion.

otherwise of contagious abortion in his herd. The buyer may still further protect himself by having newly-obtained pregnant females kept isolated, pending a test of their blood or until they calve. By sending blood samples to

a suitable laboratory for examination by the agglutination test, a person is acting discreetly. This can conveniently be done and a report received back within a week. The same thing should be done in the case of a bull. In purchasing cattle at public auctions from unknown herds, the safest plan is to select only young cattle at weaning age, or not over one year old and which have not been bred. In all cases where the blood of an animal reacts to the test it indicates that it is infected, and is not a safe animal to be added to a clean herd, but should be excluded and, if the agreement of purchase will permit, should be returned to the seller or the original owner. In the event of outside cows being permitted to come to be bred to the bull of a clean herd, they should only be bred providing they are free from vaginal discharge, and service should take place in a small yard or pen kept for that purpose. Needless to say, outside cows from doubtful herds should not be allowed to mingle with those of a clean herd, nor to occupy the pastures on the premises in order to prevent contamination. Precautions should also be taken in the case of cows from a clean herd being sent to another herd to be bred. Likewise precautions must be taken in the case of clean-breeding females being taken to live stock fairs and exhibitions. The precautionary measures which have been described are quite simple and applicable to any herd and if consistently carried out *may prevent infectious abortion from entering a clean herd.* Should perchance a cow abort in a supposedly clean herd, it should be regarded, irrespective of excusable circumstances, as being probably the contagious form rather than purely accidental, and precautions taken accordingly. In the event, therefore, of any animal aborting in the stable, or at pasture, it should at once be removed from the herd, and kept isolated for at least three weeks, or until it has properly cleaned and all discharges have ceased. At the end of ten days from the time of aborting an examination of her blood should be made. Immediately after the abortion has taken place the aborted fetus and the after-birth should be safely disposed of by burying deeply in the ground. All of the contaminated bedding and litter should be removed from the stable and burned. The stable walls and stalls up to a height of about six feet, and the floors and gutters should be thoroughly cleaned, and washed with a solution of ordinary lye and hot water, and then disinfected with lime wash and cresol or carbolic acid (in the proportion of one pound of cresol or crude carbolic acid to five gallons of whitewash).

What are the Best Methods to Suppress Abortion in a Herd?

The methods of procedure to be observed in dealing with an infected herd must be adjusted in accordance with the existing conditions, having in mind the size of the herd, the extent of infection in it, and the length of time the herd has been affected. In a general sense we are apt to consider abortion-affected herds as being either slightly affected or else badly affected, depending on the number of abortions, and to be guided accordingly. At the same time it should be remembered, that the extent of the infection in many herds cannot be exactly established on that basis alone. While the same general principles form the essential basis for the suppression of abortion they may, however, be modified in whole or in part to meet the various exigencies encountered in different herds. For convenience of description each method of procedure will be described separately, with the understanding that they can be modified or combined as may seem necessary.

The Method of Testing the Herd and Removing the Reactors.

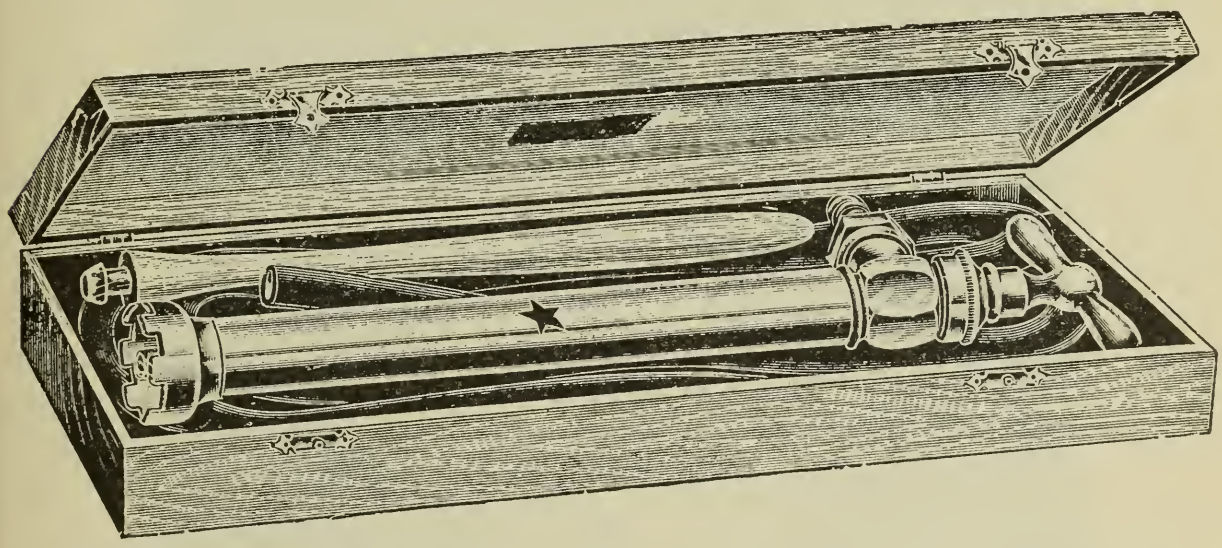
This procedure requires the entire herd to be tested, and is applicable to most herds as a means of determining the number of infected animals in a given herd. Samples of blood should be taken from each animal, and sent to a laboratory for examination by the agglutination test as already explained. Should only a few of the animals in a given herd react to the test, the wisest thing to do in such a case would be to immediately remove the reactors, thoroughly clean and disinfect the stable and take the necessary precautions to prevent further infection. This should not be taken to mean that the removal of a few reactors will end the trouble in all cases, but that it may in some cases, and in any event will get rid of some of the spreaders of infection. As already stated, it is the animals which react most intensely that are the most likely to abort, and are the worst spreaders of infection to others. Additional tests should be made in from thirty to sixty days, and any additional reactors should be expelled from the herd until there are no more reactors. Each time reactors are discovered the stable should be thoroughly cleaned and disinfected. Where a large number of reactors are found in a herd, the best plan is to keep the herd intact and consider it as an infected unit, and deal with it under the combined methods of sanitation, segregation and sexual hygiene, supplemented by the judicious use of vaccines.

The Method of Sanitation and Segregation.

This method of procedure provides for the isolation of all pregnant females in an affected herd for a week before calving, and for at least a week after calving, and for three weeks or longer in cases where there is a vaginal discharge. It recognizes the principle, that during this time lies the greatest danger of spreading infection. It likewise involves the setting apart of as many stalls as may be required for use as *maternity stalls* for the segregation of all cows as they approach calving. These so-called maternity stalls should, if possible, be provided at one end of the stable, and should preferably be box stalls, with good floors to permit proper cleaning and disinfection. They should always be kept clean and well bedded. The soiled bedding and manure should be removed regularly each day, and safely disposed of so as not to be accessible to the other cattle. When a cow calves the after-birth and all of the soiled bedding should be removed and burned up completely or else safely buried in the ground. Under no consideration should the soiled bedding and litter from a stable containing infected cattle be thrown outside in a yard to which any of the cattle on the premises have access to or be placed within their reach. Before the cows are released from the maternity stalls their hind parts should be washed clean. Having in view the fact, that calves being fed on milk from infected cows may be expelling the germs with their fecal discharges (manure), it is advisable, where possible, to keep the calves in separate pens or yards until they are weaned, so as to lessen the danger of their discharges spreading infection through contaminating the surroundings of cattle of breeding age. The soiled bedding and litter removed from the calf pens should be safely taken care of. Sanitation under this method implies cleanliness of the barn and yards at all times, and thorough disinfection from time to time as may be required. The bull should also be kept in a separate stall, and exercised in a separate yard, and service should be carried out on neutral ground. This can easily be arranged for on any farm by means of a breeding pen or small yard being kept for service purposes only. These precautions are quite adaptable to any herd under average farm conditions, and if consistently regarded will furnish satisfactory results.

What Should be Done when a Cow Aborts?

As soon as any cow or heifer in the stable, or pasture, shows signs of aborting, or has aborted, it should at once be removed from amongst the other cattle, and placed in a maternity stall where it can be kept properly segregated. The owner should immediately consult his nearest veterinarian and be guided by his advice. Pending this, the stall occupied by the aborting animal should be properly cleaned, all of the bedding and litter removed, and burned together with the aborted fetus and the after-birth. The stall should then be thoroughly washed with a solution of lye and hot water and then disinfected with carbolic acid (or cresol) and lime wash. The womb of the aborting cow may require to be flushed out with a mild lukewarm antiseptic solution, such as a one per cent. Lugol's solution of iodine followed by a saline solution, made by adding two ounces of fine dairy salt and bicarbonate of soda to a pail of lukewarm water. On no account should strong antiseptic solutions be used as they are harmful



The kind of injection pump which is required to properly flush out the genital passage.

to the womb. The flushing of the womb should be done by means of a return-flow catheter and injection pump under the direction of the attending veterinarian. When a veterinarian is not available, the owner must necessarily rely on his own resources in accordance with the prescribed suggestions. The aborting cow should be kept segregated in the maternity stall for a period of three weeks or until all discharges have ceased. At the expiration of ten days after she aborted a sample of her blood should be sent to a laboratory for the agglutination test. Should her blood react to the test and she is the only one which has aborted, it would be advisable to have the reacting animal expelled from the herd awaiting further developments, or as revealed by a test of the remainder of the pregnant animals. Where several animals abort during the year the herd should be considered as an infected unit, and each case should be dealt with as it occurs in the manner already described relating to sanitation and segregation.

What Should Be Done in Cases of Retained After-Birth?

The owner of a good herd will find it a wise policy to employ his veterinarian to take care of cases of retained after-birth. It is becoming more generally realized that retention of the after-birth in well-bred cows is quite a serious condition. The old methods of forcibly pulling the after-birth away is no

longer practised by intelligent herdsmen, as so much trouble has followed this practice of dealing with it. The improper and imperfect removal of the after-birth is one of the most frequent causes of metritis and sterility. In most cases of retained after-birth the membranes should be carefully and completely removed if not expelled within from one to three days. During this interval of time the womb should be washed out once every day with a lukewarm antiseptic solution, such as a one per cent. solution of lysol or a one-in-one-thousand solution of potassium permanganate. In many cases, the frequency of washing of the womb may be reduced by the use of antiseptic preservative powders in gelatine capsules. These uterine capsules can be procured by the owner from his

A clean cow in accordance with the method of sexual hygiene.

veterinarian, and should contain an ounce of an antiseptic powder, such as equal parts of iodoform and boracic acid. Another useful antiseptic powder is two drams each of chloride of lime and boric acid and four drams of starch. The capsule containing the antiseptic powder should be introduced by the hand into the womb, and placed between the placenta and the uterine wall within a few hours after calving, and then repeated the following day. This practice will be found extremely useful in all cases where the after-birth is retained. As soon as the after-birth is expelled it should be burned, or safely buried together with all of the soiled bedding and litter.

The Method of Sexual Hygiene

In all cases of abortion there is danger of a septic condition of the uterus developing which may lead to sterility. The essentials of sexual hygiene consist in irrigating the genital passage with mild antiseptics until all discharges have ceased. The womb should first be flushed out with about two gallons of a one per cent. Lugol's solution of iodine, followed by a saline solution made by adding two ounces each of fine dairy salt and bicarbonate of soda to a pail of clean lukewarm water. The flushing with the saline solution may be repeated every few days until all abnormal discharges cease. When an abortion occurs, the aborting cow, and all the exposed pregnant ones occupying stalls adjacent to the aborting animal, should have their hind parts, including the tail, hips and udder washed thoroughly, with an antiseptic solution such as a two per cent. solution of lysol or creolin. Cows which have aborted should be kept segregated for at least a week, and for such further period of time as may be necessary, in the event of any discharges coming from them. This is important because the discharges may contaminate the surroundings of the other cattle, and prove a source of infection by infecting the bedding, litter, feed, pasture, or water. At the end of the isolation period, before allowing aborting cattle to mingle with the other members of the herd, it is advisable again to thoroughly wash their hind parts, and disinfect the stable in which they have been kept. Cows which have aborted should not be bred if they show any discharges coming from the genitals. The flushing of the womb should be done with a special return flow catheter and an injection pump. In the case of the bull, special precautions may be taken to have the sheath irrigated with a mild antiseptic solution such as a three per cent. solution of borax, each time after serving aborting cows. It should be kept in mind that the bull should only be permitted to serve cows on neutral ground for the reasons already mentioned.

The Judicious Use of Vaccines

This method of procedure is becoming more widely employed, as a supplemental treatment in badly affected herds, to assist in obtaining a larger percentage of living calves at full term. In the vaccination of cattle against abortion two kinds of bacterial vaccines are recommended, namely, "Abortion Vaccine" which is a living culture of abortion bacilli, and "Abortion Bacterin," which is a killed culture of abortion bacilli. The owner should consult his veterinarian regarding their proper use and have the vaccination done under his guidance.

Abortion Vaccine or living culture.—The use of the living culture vaccine is indicated in badly affected herds for the purpose of establishing herd immunity. It should be administered to all of the non-pregnant cows and heifers in the herd two months before they are bred. It is necessary to observe this precaution, because animals should never be bred until at least sixty days have elapsed since the time they were vaccinated with the living culture. If an animal is properly immunized, by this method for two successive pregnancies, by repeating the vaccination after calving, there is little danger of the animal thus treated aborting afterwards. The dose of the vaccine is 20 c.c. injected subcutaneously two months before breeding. The living culture vaccine should not be used on pregnant animals, nor in herds in which the disease is not present nor fully established.

Abortion Bacterin or killed culture.—The use of bacterins or killed cultures is indicated in the case of pregnant animals and non-pregnant animals that

must be bred at once. There is still considerable doubt as to the value of the bacterin treatment, as it has not as yet been proved altogether as successful in conferring protection against a subsequent abortion as expected. At the same time many reputable and trustworthy practitioners claim good results from their use. They are recommended as producing the best results if used within the first two months of pregnancy, the dose being 20 c.c. given subcutaneously. During later stages of pregnancy than sixty days monthly injections of 5 c.c. should be given subcutaneously.

In comparing the results of treatment of affected herds the use of live cultures has been found more satisfactory than the use of killed cultures.

How Can Reliable Vaccines be Obtained?

Reliable abortion vaccines and bacterins are prepared and sold by a number of commercial biological laboratories. Reputable laboratories sell these products only to qualified veterinarians, because they do not consider it advisable or safe as yet to allow an indiscriminate use to be made of them, which might be injurious. They can at all times be procured through qualified veterinarians and used under their direction. The laboratories of the Ontario Veterinary College will be prepared to supply a limited amount of abortion vaccine to qualified veterinary surgeons, providing an owner of cattle makes a request that he desires to have his animals vaccinated, and furnishes the name and address of the veterinarian he desires to employ, and the number of animals to be treated. On receiving such a request, the vaccine will be sent to the veterinary surgeon, with directions as to its use, and on condition that he will report to the College the results obtained. As the keeping of careful records and furnishing of reports to the College will take considerable time of the veterinarian, he will receive the vaccine free of charge to compensate him for his trouble. Owners and veterinarians desiring to avail themselves of this arrangement may do so, by writing to the Principal, Ontario Veterinary College, Guelph, Ontario.

Can Abortion be Cured by Certain Drugs and Proprietary Remedies?

The internal use of drugs and certain proprietary remedies as alleged cures for contagious abortion of cattle have been repeatedly found to be of no real value. Generally they are highly praised for a time, but on extended trial they are proved useless. The carbolic acid treatment, which was particularly popular for a time, consisted in administering it in dram doses at intervals of several days throughout pregnancy. Another drug, known as methylene blue, was also advocated as a likely cure, to be given in doses of one or two tablespoonfuls daily in the feed for a period of five or six weeks during pregnancy. While no serious objection to the use of either of these drugs need be taken, nevertheless their use has shown them to be of no benefit, and their popularity has rapidly diminished among breeders. The value of potassium iodide has long been recognized as an alterative to correct certain deficiencies, especially of thyroid origin. The most common of these conditions is goitre, for the prevention of which potassium iodide may be used in dram doses, given once a week, added to the feed or water during the period of pregnancy. This drug is not, however, a cure for infectious abortion in cattle. Many secret proprietary remedies are placed on the market as alleged abortion cures. They are usually lavishly extolled, by means of pamphlets, and advertisements in farm papers, to attract the attention of breeders. The presence of these adver-

tisements from time to time in certain papers inclines the breeder to think that they are endorsed by the agricultural press, and are of value to him. The fact is they are not endorsed even by the papers in which they appear, but are merely carried as advertising matter, and a number of agricultural papers refuse to carry deceptive advertising matter of that kind. Invariably, they are quack preparations, being exploited for personal gain and large profits, and their promoters avoid ridicule by not divulging the names of the ingredients, knowing that their commercial success is sustained by secrecy. Fortunately, as already stated, there is a growing sentiment among breeders "against being further exploited" by vendors of alleged cures for contagious abortion. It should always be kept in mind that abortion is a self-limiting disease in a herd, and if a herd is kept intact a certain percentage of the animals acquire a degree of immunity or self-protection, which enables them to carry their calves the normal period of time. The development of this immunity favours the medicine vendor, and is the reason that so many worthless substances can be palmed off as alleged cures for contagious abortion. If, in spite of this warning, owners of cattle prefer to rely on their own judgment as to the drugs or remedies they should use, it is their privilege to do so.

The dairy herd should be allowed sufficient exercise and as large a use of leguminous pastures as possible to prevent mineral deficiency.

Should Mineral Deficiencies be Corrected?

During recent years a great deal of consideration has been given to the possible effects of mineral deficiencies, reducing the vitality, and lowering the resistance of animals against abortion disease and sterility. This seems to be more especially the case in dairy herds which are kept at a high state of milk production, remaining indoors most of the time on a fixed ration deficient in mineral elements, namely, lime and phosphorus. Run-down and exhausted pastures are generally deficient in minerals. Worn-out fields and pastures should therefore be rejuvenated by a liberal application of mineral fertilizers in order that grains, forage, and pasture containing a sufficient amount of minerals may be grown for feed. In all cases of nutritional deficiency, the nature of the

deficiency should be determined and corrected as far as possible. In a general sense the deficiencies can usually be corrected in a herd by liberal feeding of a balanced ration, allowing sufficient exercise and as large a use of leguminous pastures as possible. Where mineral deficiency is presumed to be present, direct benefit may be derived from a mineral tonic to the feed, such as lime phosphate, salt, potassium iodide and sulphate of iron.

What are Some of the Common Causes of Sterility?

Of the prevailing causes of sterility, diseases of the genital tract occurring as a phase of abortion are the most common. In these cases, the exciting cause is infection which produces certain abnormal changes that prevent conception. There are also other conditions which should receive consideration. A brief description of the common causes may be useful.

Cervicitis.—This is an inflammation of the mucous membrane of the cervix or neck of the womb. It is sometimes induced by rough attempts at opening the neck of the womb, facilitating infection.

Endo-metritis.—This is an inflammation of the lining membrane of the uterus. It is frequently caused by infection of the womb incidental to abortion or retained after-birth.

Pyometra.—This is the name applied to an accumulation of a quant'ty of pus in the womb. It is most frequently caused by metritis following retention of the after-birth. It is one of the common causes of sterility, and is characterized by a purulent discharge from the vulva, which is frequently most noticeable when the cow is lying down.

Salpingitis.—This name is given to an inflammation affecting the oviducts or fallopian tubes which extend from the end of the womb to the ovaries.

Cystic Ovaries.—This is a common disease of the ovaries, and is characterized by degenerative changes, and the development of cysts filled with serous fluid. These cysts destroy and replace the gland tissue of the ovary, preventing ovulation. Cows which have cystic ovaries frequently become nymphomaniacs or chronic bullers.

Persistent Corpus Luteum.—In some cases the corpus luteum or so-called brownish body persists in the ovary, preventing ovulation. In these cases estrum is inhibited and the animal fails to come in season at the regular periods.

"*Free-martins.*"—The term free-martin is applied to the female of twin calves, more particularly when they are of different sexes. It is a well-known fact that the free-martin will seldom breed. In many cases they do not come in season, and do not show any inclination for the bull. Their generative organs are generally imperfect, and nothing can be done to make them breeders. They should not be sold as breeders, but should be fattened and sold for beef.

White Heifer Disease.—Some breeders claim that there are a larger number of white heifers infertile than is the case with heifers of another colour. The ground for this belief is the fact that in certain strains of white cattle there is an imperforate membrane (the hymen) present in the vagina, which prevents conception. In some cases the vagina becomes filled with fluid or pus. As a result of these peculiarities, the name white-heifer disease is used in referring to this type of non-breeder. In these cases the animal strains a great deal, and an examination of the genital passage reveals the existing membrane.

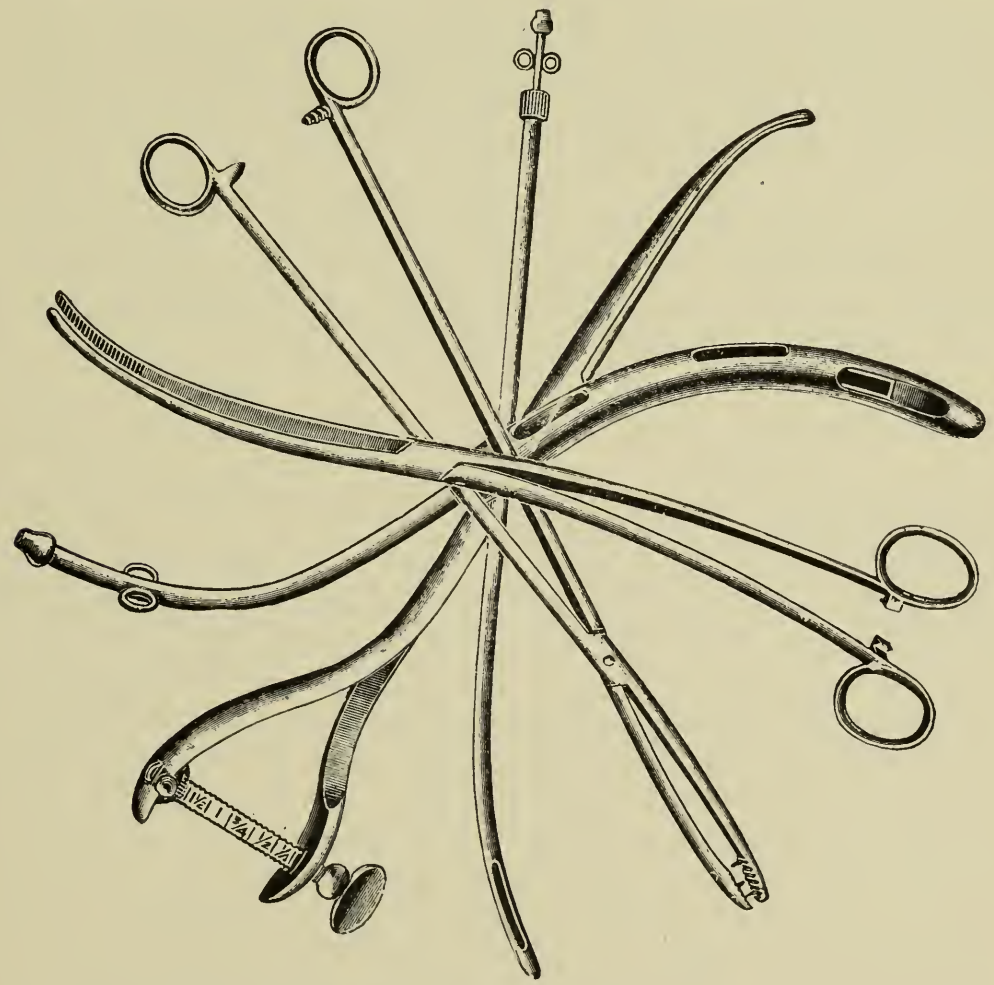
Obesity.—It is generally recognized that a percentage of cattle which are excessively fed, too highly fleshed, and fatted for show purposes, become cor-

pulent to an extent that reduces their fecundity. These cases can only be helped by a return to moderate feeding and sufficient exercise.

Mineral Deficiencies.—There is a growing belief that mineral deficiencies in the diet have a predisposing influence in causing sterility through ovarian degeneration.

The Prevention and Treatment of Sterility

Sterility may be prevented in many cases of abortion by observing the essentials mentioned under the method of sexual hygiene. Whenever a cow or heifer fails to conceive after one or two services, she should be carefully examined by a qualified person to determine the trouble, and receive such treatment as



Set of instruments used in the operative treatment of irrigating the womb of cows to overcome sterility following abortion. The above set includes the Albrechtsen uterine dilator and return flow catheters and a pair of the Knowles uterine forceps.

may be indicated. On no account should a hasty attempt be made to open the neck of the womb by prodding it with a pointed stick, as many cows are permanently injured as a result of this practice. In all cases of sterility, if the barren females are only of ordinary beef value, they can be fattened and sold for beef. In the case of valuable females manifesting difficulty in settling, they should be examined as soon as possible. If the case is one of disease of the genital organs expert attention by a skilled veterinarian is necessary. The necessity of expert treatment is for the purpose of treating the womb by what is known as the Albrechtsen method—to massage the womb, to manipulate the

ovaries with the hand, to rupture cysts if present, and to expel retained corpus luteum. This operative treatment can only be properly done by a skilled person with suitable instruments. It is successful in probably at least fifty per cent. of cases, thus resulting in restoring many valuable cows to breeding usefulness.

Is the Bull Ever at Fault?

While as a rule the female is most frequently to blame in cases of sterility, at the same time there are cases where the fault lies with the male. Some bulls are lacking in sexual vigour as the result of excessive sexual use when too young, likewise too frequent and excessive sexual use at maturity, abnormal modes of living and lack of exercise. In these cases the spermatozoa or "seed" may be impaired and inactive or entirely absent from the semen. These defects in the bull can sometimes be corrected by regulating his sexual services, correcting his mode of living and insisting on sufficient exercise. In some instances the cause of infertility in the bull is a phase of the abortion disease in a herd. The genital apparatus of the bull may become diseased, gradually lessening his procreative power. To lessen the danger of the bull becoming infertile he should be kept in a clean stall and provided with a paddock for exercise. His genital tract may be kept sexually clean by irrigating the sheath with a normal saline solution. In treating the inside of the sheath it can be readily irrigated by means of an ordinary metal syringe or a rubber bulb syringe.

The Prevention and Treatment of White Scours in Calves

Where abortion disease exists in a herd white scours may occur among the calves, causing severe losses if not checked.

Prevention.—As a general precaution, the young calf should be placed in a clean, dry, well-bedded pen, and kept warm. The navel should be disinfected by immersing it in a one in one thousand bichloride solution. A very good way is to place the solution in a cup, and hold the cup up close against the belly, and allow the navel to remain immersed for a few minutes. The navel and the skin around it can also be painted with tincture of iodine. Some prefer astringent dusting powders to encourage dessication of the navel more quickly. For this purpose tannic acid, powdered alum, camphor, and starch in equal parts are useful. The calf should be carefully dieted and *during the first twenty-four hours of its life it should be fed sparingly as over-feeding is dangerous.* For the first week of the calf's life it should be fed on its own mother's milk, as the colostral milk is beneficial to it. The feed pails should be kept clean. The surface of the udder and teats should be cleaned before milking or allowing the calf to suck. On infected premises the healthy calves should be immediately removed from among the sick ones and kept in separate pens until all danger is over. While these general precautions are indicated, nevertheless they can be rendered more effective by definite treatment.

Treatment.—For this purpose what is known as "Anti-White Scours Serum" is used, and has been found very valuable both as a preventive and curative treatment. In herds affected with white scours among valuable calves, veterinary assistance should be obtained for the administration of the serum treatment. As a preventive treatment, the calf should receive 20 c.c. of the serum subcutaneously soon after birth. In affected cases, as a curative treatment, the calf should be given large and repeated doses of the serum. As a rule from 30 c.c. to 50 c.c. of the serum should be given at a single dose, either subcutaneously

or intravenously, and repeated at intervals of two or three hours for as long as may be required to control the diarrhea. In many cases the serum treatment will control the diarrhea within six hours, and if it is promptly used will greatly reduce the mortality. In ordinary cases of diarrhea occurring in calves a few days old, they may be fed on boiled milk to which may be added half a teaspoonful of lysol or formalin, morning and evening, until relief is afforded. The serum used for the treatment of white scours can be procured by the owner, through his veterinarian, from any reliable biological firm. In all outbreaks of white scours the calf-pens should be cleaned and disinfected.

Summary of Leading Points

1. In purchasing breeding cattle, make careful enquiries to ascertain if the herd from which they are being obtained is free from abortion disease.

2. If doubt exists as to their freedom from this disease, have all newly-obtained pregnant females tested, or keep them under observation until they calve.

3. Cows should be placed in maternity stalls to calve.

4. Whenever a cow aborts keep her isolated until she cleans.

5. Thoroughly clean and disinfect the stalls in the stable. The bedding and litter removed from the stalls should be burned, together with the aborted fetus and the after-birth.

6. Wash the hind parts of all the exposed pregnant cows with an antiseptic solution.

7. Cleanse the genital passage of the aborting animal in all cases of retained after-birth. Irrigate the womb with a mild, warm antiseptic solution or a saline solution. Make use of uterine antiseptic capsules.

8. Do not allow cows with retained after-birth to remain in stalls adjacent to other pregnant females.

9. Keep aborting cows segregated from the others so long as they are discharging. Wash their hind parts before allowing them to return to the herd.

10. Allow a period of one month to elapse before returning aborting cows to the bull. Wash the bull's sheath after service of aborting cows.

11. Do not allow the bull to serve cows which have a discharge from the vulva. Serve all cows on neutral ground.

12. In affected herds obtain the advice of a qualified veterinarian as to the use of vaccines combined with sanitary measures.

13. In badly affected herds best results are obtained from the use of a live culture vaccine administered to the non-pregnant females two months before breeding.

14. In the case of valuable cows becoming barren, the services of a skilled veterinarian should be obtained for the purpose of treating the womb and ovaries.

15. If calves become affected with white scours, immediately separate the sick ones from the healthy. Consult a veterinarian regarding the use of calf-scours serum in conjunction with sanitary measures.

16. Nutritional deficiencies should be corrected as far as possible by supplying mineral elements in the feed.

ONTARIO VETERINARY COLLEGE
GUELPH

Ontario Department of Agriculture

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BULLETIN 305

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DISEASES OF POULTRY

By Ronald Gwatkin, D.V.Sc.

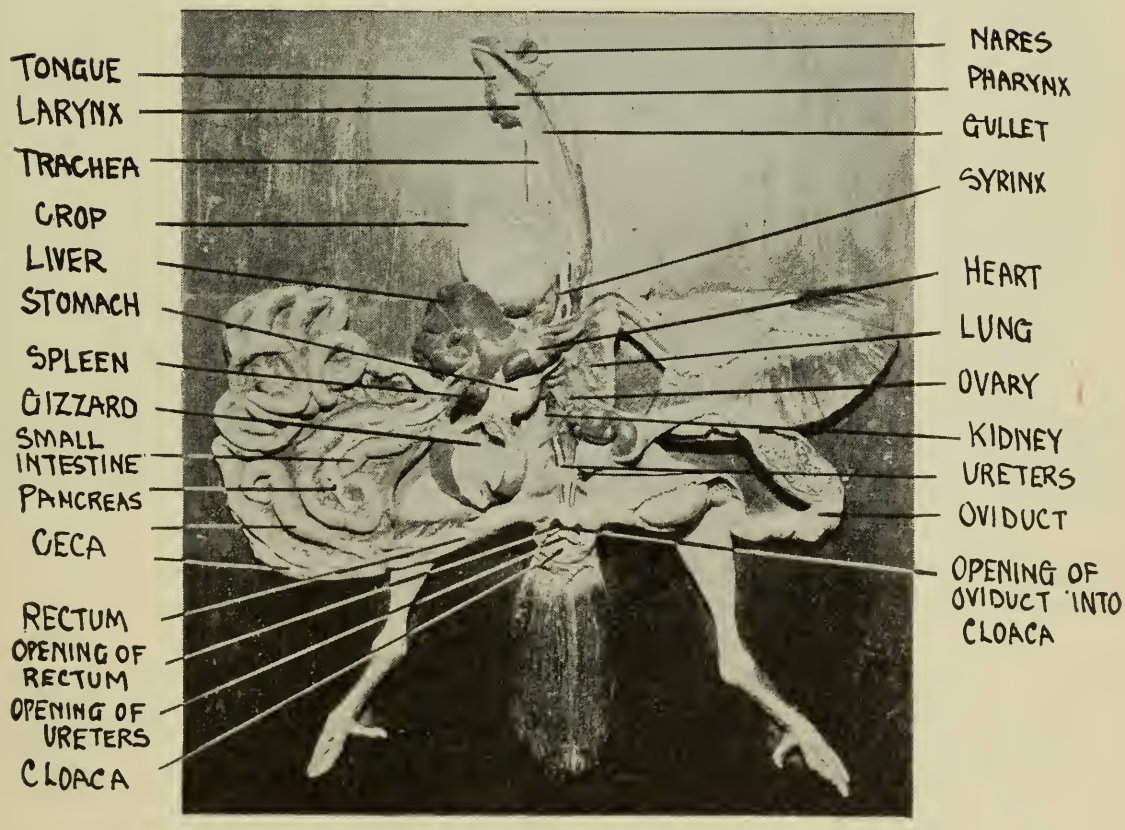

Fig. 1.—Model of hen showing principal organs. (Original.)

TORONTO, MARCH, 1924

POULTRY DISEASES

By Ronald Gwatkin, Department of Bacteriology
Ontario Veterinary College, Guelph, Ont.

Poultry are subject to many diseases, and owing to the manner of keeping them the infectious ones may spread very rapidly among them. The aim of this bulletin is to describe briefly the more important diseases prevalent in Ontario and to outline the known methods of prevention, control and treatment where such is possible.

How to Examine for Disease. In order to control disease it is necessary that the particular form be recognized, and this may be accomplished by a careful summing up of history, symptoms and *post-mortem* findings. Very often it is only by an examination of the organs after death that the trouble can be arrived at, and in order to appreciate the changes produced by disease it is essential to be acquainted with the appearance of the normal organs. In some cases the changes are so marked, as in advanced tuberculosis, that they cannot be overlooked, but in others they are so slight as to be missed by anyone but an experienced pathologist, and at times no naked eye lesions at all can be seen.

Treatment. Individual treatment is not practicable in many cases where birds are kept in large numbers, and efforts should be concentrated rather on prevention and control. In the case of valuable birds, or where there are not more than can be conveniently handled, individual treatment is beneficial in some instances and worth the labour involved. The most suitable form of treatment is that which can be administered to the birds in feed or water, and such mass treatment should always be used when safe and efficient.

HOW TO MAKE A POST-MORTEM EXAMINATION

Value of a Post-Mortem Examination. Very often it is impossible to decide what is the matter with a bird, or birds may be found dead that were not previously known to be sick. In these cases a careful *post-mortem* examination may reveal the cause. It must be remembered, however, that fowls may die of such conditions as heat exhaustion, from some lesion in the heart that escapes notice, from excessive fat in the same organ, or to some apoplectic condition, in which cases no changes will be noticed.

Instruments and Method of Opening. If many *post-mortem* examinations are to be made the following instruments will be found valuable: A pair of heavy bandage scissors, a sharp knife, a pair of fine scissors, and, if desired, a pair of thumb forceps. The dead bird should first be carefully examined for any external conditions. Then lay it breast upwards on a piece of board, and extend and drive a nail through each wing and foot. This holds the bird firmly and facilitates the making of a careful examination. Make an incision through the skin from the under side of the beak back to the vent and remove the skin down to the level of the board, as shown in Fig. 2. Then carefully cut into the abdominal cavity above the cloaca, insert the heavy scissors, blunt point inside, and cut through bone and muscle right to the front of the body. Do the same on the other side and remove the breast bone and abdominal wall, taking care not to injure the liver, heart or other organs. These are carefully freed from the peritoneal and other attachments by means of the knife while the abdominal

wall is being lifted up, leaving them exposed to view as in Fig. 3. While it is not necessary to remove the skin before opening the bird, the small amount of time required for the operation makes it very desirable, banishing, as it does, the annoyance of feathers getting into the body during the examination, and permitting an examination of the subcutaneous tissues.

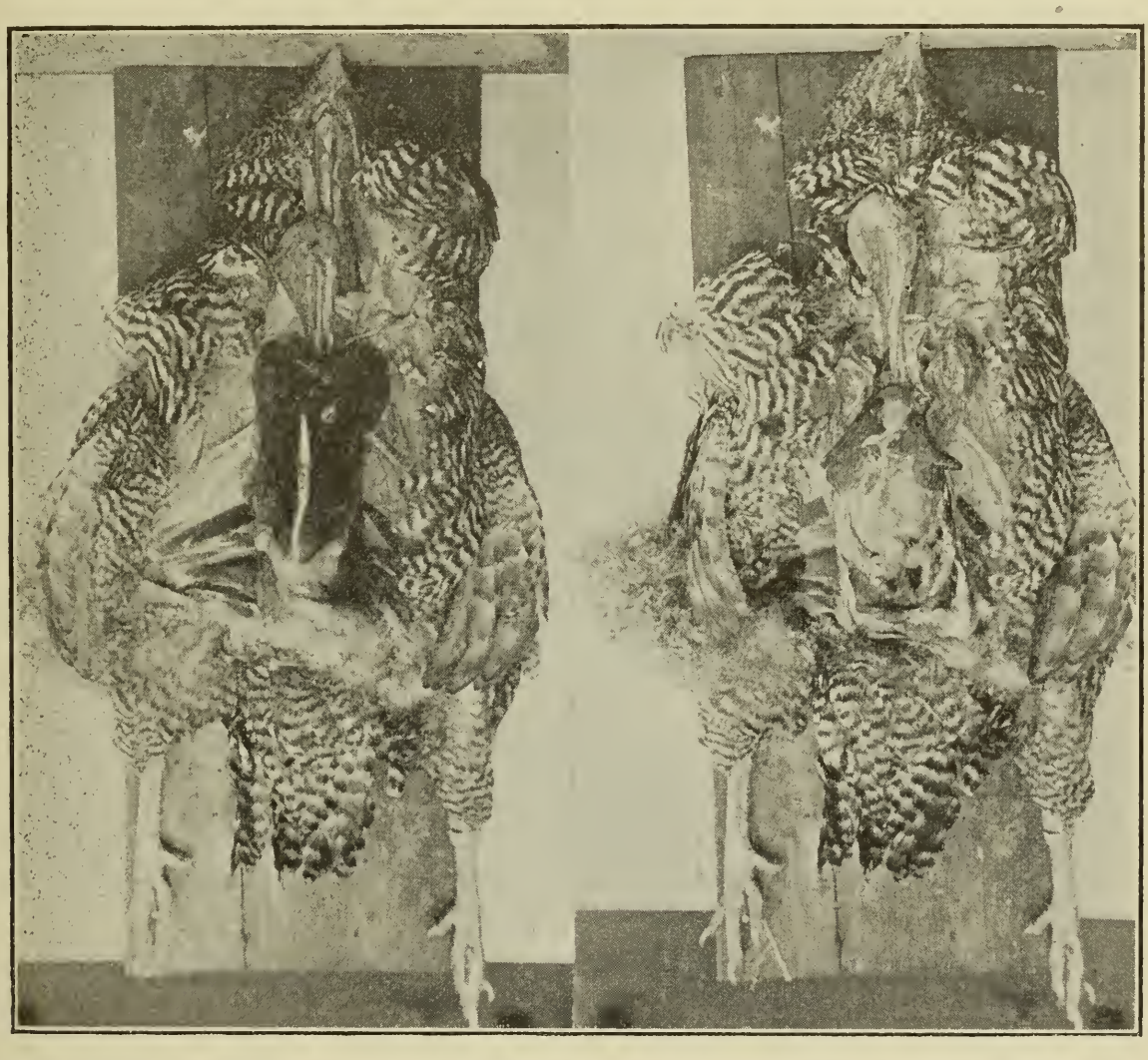

Fig. 2.—Fowl in position for examination with skin removed. (Original.)

Fig. 3.—Same fowl after removal of breast bone and abdominal wall. (Original.)

Examination of Organs. Before removing any of the organs they should be examined in position, and the presence of fluid or any other abnormal condition noted, such as blood clots, tubercles, yoke concretions and tumours.

Then the liver is examined. It should be dark chocolate brown, firm, smooth and shiny. In disease it may be enlarged and soft, contain tubercles, be changed in colour or consistency, or have greenish areas, or tumours be present.

On turning back the liver and gizzard the spleen can be observed. It is a small, somewhat round, dark red body normally, but may be much enlarged and congested in acute bacterial infections, or large and mottled in leukemia or tuberculosis.

The heart and lungs are next examined and removed. The heart should be examined for size, excessive fat, and the condition of the covering and lining membranes and heart muscle. The lungs are bright red and should be examined

for congestion or pneumonia. Congested lungs are dark red and will float, while pneumonic lung tissue will sink in water.

The trachea (windpipe) and bronchi should be opened with fine scissors and the presence of parasites, false membranes, or other exudate noticed. The condition of the larynx (opening to the windpipe) and pharynx (throat) is also observed, and the roof of the mouth can be removed for examination of the nasal passages if necessary.

The intestines are now examined externally for tubercles or signs of inflammation, and should then be opened up with the fine scissors and examined for parasites and the condition of the mucous membrane lining it. Examine the cloaca and remove the intestines out of the way, if this has not been done before opening them.

The kidneys and reproductive organs can now be seen. The kidneys are normally dark red in colour and mottled. Changes in colour and size are to be looked for. The ovary, oviduct and ureters are next examined for tumours, concretions, inflammation or rupture, and the appearance of the urates in the ureters.

The peritoneum, the membrane lining the abdominal cavity and covering the organs, should be thin, glistening and transparent. When thickened or opaque it indicates inflammation (peritonitis).

HOW TO SEND MATERIAL IN TO THE COLLEGE FOR POST-MORTEM EXAMINATION

What to Send. Birds sent in to the College for examination are frequently in such a condition that no information can be gained from them. It should be remembered that in addition to a naked eye examination it may be necessary to carry out a microscopic examination, or make bacteriological cultures, and tissue that is going bad is not suitable for this purpose. It is best to send sick rather than dead birds, as they can be killed at the College and fresh material be available. If this is not possible, send a bird that is recently dead. In very hot weather it is advisable to wrap the bird in cheesecloth, and ship in ice and sawdust.

The package should be sent by prepaid express to: Ontario Veterinary College, Guelph.

Information That Should Be Sent Regarding Birds. A letter should be sent at the same time under separate cover, giving briefly all the known particulars regarding the case, as, for example, the age of the bird; feed; number of birds in flock; conditions under which kept, as houses, runs, etc., whether raised on the premises or purchased, and if purchased, when; whether other birds have been introduced recently; date of death; if other birds are ill with similar symptoms, on the premises, in the district; if others have died; the symptoms shown; treatment employed, if any. Give any other information that may have a bearing on the case.

Value of Such a Report. A report of this nature is of value to the laboratory worker in forming an idea of what to look for, and simplifies things by eliminating certain lines along which he might be led to work by following out the information conveyed by an incomplete report. A reply will be sent at the earliest possible moment, but it must be remembered that this may take longer in some cases than in others, depending upon the amount of work involved.

HYGIENE

General Considerations. Every poultry keeper should strive to feed, house, and look after his stock in a hygienic manner, trying always to prevent disease gaining a foothold, watching closely for the earliest sign of any trouble and at once removing affected birds. More can be done towards having a healthy flock by keeping thoroughly sanitary surroundings than by any other means.

Feeding. For details regarding feeding and housing the reader is referred to Bulletin 292, "Farm Poultry," which can be obtained from the Department of Agriculture, Parliament Buildings, Toronto. Nothing should be fed that is not in good condition. Mouldy food, or that in which decomposition has commenced, may be highly injurious, and is always to be avoided. Weed seeds are often a source of trouble. Clean food and water are as essential to fowl as to any other class of livestock.

Housing. Cracks and corners that might harbour vermin in houses should be avoided. Have the structural detail such that it will not interfere with thorough cleaning and disinfection. There should be 3 or 4 square feet of floor space for each bird in winter houses. Thorough ventilation is important, but it must be arranged to avoid drafts, which chill and lower the resistance of the birds, making them an easy prey to infections and also to certain non-infectious conditions. Dampness is equally bad for poultry, and may arise from insufficient ventilation to remove the exhaled moisture, or from the site or construction of the house.

Sunlight. Darkness is an enemy of poultry, permitting, as it does, the accumulation of material that may harbour infection, and lacking the beneficial action of the sun. Sunlight is a natural disinfectant. Certain of the rays have a destructive action on bacteria. Provision should be made for the admission of as much sunlight as possible into houses, especially during the winter.

Cleanliness. Houses and runs must be kept clean and sanitary, droppings removed and litter changed often, and disinfected in the spring and fall at the least.

Care of Runs. The land on which birds are running must be looked after, as constant ranging pollutes the land quicker than the soil can be purified, and birds will not do well on it, probably largely due to the number of parasites present. If enough land is available, runs should be used one year and a crop of rape or grain grown on it the next year to clean it up. In any case it should be annually seeded down or limed and spaded under. Never scatter droppings from fowl where chicks will be running, as this may expose them to infection with harmful bacteria or infestation with parasites.

Exercise. Exercise is of the greatest importance, and must be obtained by making the birds scratch for their grain when no other opportunity of exercise is offered, as in winter houses. The results of lack of exercise are very forcibly shown in well-fed birds that are in small cages for several months. Leg weakness may occur, or a decided falling off in condition.

Sickness. On the first sign of sickness remove the affected bird or birds. Do not wait for a day or two. If the condition turns out to be not of an infectious nature no harm has been done, and if infectious a great deal of trouble may have been saved by this early removal. If shown to be an infectious disease,

at once clean up, and disinfect thoroughly, repeating the process as more infected birds are removed. Fowls live very closely, and consequently only the greatest care will prevent the rapid spread of infectious diseases when introduced into a flock. Dead birds should be burned or buried deeply, otherwise they form important centres of infection for the other birds.

Quarantine. A good deal of trouble is caused by the introduction of new breeding stock, and by the return of birds from exhibitions. These should be kept separate from the main flock for a period of 2 or 3 weeks, care being taken that the quarantine is complete, and that possible infection is not carried on hands, clothing, or utensils from the quarantined birds to the healthy flock. We recently had occasion to report on an outbreak of fowl cholera occurring in a pen of birds. One of these cockerels had escaped and been at a neighbour's premises for a week. It was placed back with the others and shortly afterwards most of the pen died. It was later found that the neighbour had lost most of his flock that fall. If the returned bird had been carefully quarantined this loss would have been avoided. If possible the quarantine house should be looked after by some one who does not go among the other birds.

HOW TO DISINFECT FOWL HOUSES

Preliminary Cleaning. Remove all litter and burn it as near the house as is safe, to avoid contamination of the surrounding soil. Remove roosts, nests, and everything that can be taken out. Scrape and place in the sun until ready for disinfection. Empty all grain, mash or grit hoppers, and do not use the contents again unless boiled. Boil or scald utensils. Remove and scrub window frames. Take down and scald cotton. Then sweep down the inside thoroughly and brush everything out. This material should be burned or buried. Hard droppings may require soaking and scraping off. Then hose or swab out the house, or better still, scrub it out with a scrubbing brush on a handle, using boiling water and lye.

Disinfection. When the house is dry spray it with some suitable preparation, such as thin strained whitewash, made with quicklime, to which is added five per cent. of crude carbolic acid, or two per cent. of compound solution of cresol, or other good disinfectant. The lime, as well as having some germicidal action when fresh, has the advantage of showing whether any parts have been missed. All cracks should be filled up with the sprayer. A brush may be used, but does not get the fluid into the cracks so efficiently. Roosts, boxes, etc., should be soaked in the solution or thoroughly sprayed before replacing.

If an infectious disease has been present it is well to repeat the spraying a second time when the first application is dry. The runs, if not too large, should be covered with quicklime and spaded under.

COLDS, ROUP AND AVIAN DIPHTHERIA (CHICKEN-POX)

The relationship of the various diseases of the head and respiratory passages of fowls has always been a matter of dispute, some claiming that the same virus is the cause of all of them, others maintaining that the causes are different.

From our experience of these diseases in Ontario we think it best at the present time to consider them under the heads of colds, roup, and avian diphtheria or chicken-pox. It seems not unlikely that colds and roup should be grouped together, but this is a matter that requires further study.

COLDS

Colds, or catarrh of the nasal passages and head of fowls, seem in many respects to resemble colds in the human family. While a large number of birds may be affected, losses are usually light. The condition occurs with the first bad weather in the fall, especially where living conditions are not good, as in damp, drafty, or poorly ventilated houses, where insufficient space is available, or feeding conditions wrong.

An outbreak of colds among a large number of birds in a house at the same time is probably due to the lowered vitality of the birds, permitting infection with usually harmless bacteria. We have constantly failed to transfer the condition to other fowls by injecting the nasal discharge of affected birds into the mouth and nose of healthy ones, even when especially poor, weak ones were chosen.

Symptoms. The birds become dull, the eyes are watery, and there is a watery discharge from the nostrils which may become thick and sticky, blocking them so that the birds have to breathe through the mouth. In the majority of cases, however, the discharge does not go on to this stage if attended to, but dries up in the course of a week. The sinuses or sacs under the eyes may swell, but not commonly.

Prevention and Treatment. Dry, well-ventilated quarters, hardy, healthy birds, and proper feeding are the best preventive measures, but colds may appear under the best conditions. Take the affected birds into warm, dry, well-ventilated quarters and give half teaspoonful of epsom salts to all the birds in the flock in their mash. Wash out the nostrils if stuffed up, and also the badly affected eyes, with boracic acid, one ounce to one quart of warm water or one teaspoonful of potassium permanganate to one pint of water. A syringe or dropper may be used and the syringing done through the nostrils or through the cleft palate, or the birds' heads may be dipped, allowing the fluid to run into the cleft, and taking care not to hold them under too long. Good quarters and a laxative are usually all that is necessary.

ROUP

This disease resembles the common cold at its onset, but is more severe, causing heavy losses at times. It is an infectious disease, the cause of which is not known. The lining of the nose, eye, sacs below the eye, the larynx and windpipe are attacked, and occasionally pneumonia develops. The weak birds are the most susceptible. The strong ones may resist the infection or have only a mild attack. Living, weather, and feeding conditions probably play an important part in this disease.

Symptoms. At first these are similar to the common cold, but the birds become more depressed and ill. The discharge from the nose and eyes, at first watery, becomes thick and sticky and the birds sneeze or cough in their efforts to expel it. A very offensive smell is present. The sinuses under the eyes become swollen and the eyelids gummed together. One or both eyes may be affected. Appetite goes, and the birds mope with drooping wings, ruffled feathers and the mouth open, gasping for breath. Bubbling noises are heard due to partial obstruction of the windpipe. The eyes may be destroyed if the cheesy material is not cleaned out of them. The birds become unable to hunt for food, and have little desire for it when offered to them. They become progressively

weaker and may die in about ten days, though a good many chronic cases will last for a couple of months or more.

Post-Mortem Appearance. The lining of the mouth and nose are inflamed. A thick, sticky discharge is present. The windpipe and lungs may be affected in some cases, and there may be a thin, foamy, sticky material in the windpipe.

Treatment. Bad cases or weaklings should be destroyed. Isolate affected birds, clean up, and disinfect. The birds to be treated should have warm, dry, well-ventilated quarters. Give half teaspoonful of salts twice a week. Feed nourishing, tempting food. Massage as much material as possible out of the nose, clean out the eyes, open the swellings under the eyes with a sharp knife and clean them out. Then use the boracic acid or potassium permanganate solution to syringe out or dip the heads, as described under the treatment of colds. Individual treatment of this kind may be very effective, especially with the

Fig. 4.—A bad case of roup photographed two days before death. (Original.)

stronger birds. Recovery is usually slow. It is best not to keep those birds that do not apparently make a good recovery, as they may carry over infection and be the cause of another outbreak.

Prevention. Quarantine new and exhibition birds. Keep out wild birds as far as possible. Remove any sick bird until the cause of its trouble is found. Clean up and disinfect if it appears to be roup, and put one-third teaspoonful of potassium permanganate in each gallon of drinking water. Watch the birds closely, removing affected ones at the earliest symptoms.

AVIAN DIPHTHERIA (CHICKEN-POX)

This is a highly infectious disease caused by an invisible virus that attacks the lining membrane of the mouth, throat, windpipe, nostrils, and eyes, producing false membranes, and forming scabs on the combs and wattles, and sometimes on the skin.

The disease may appear in three forms. An infection of the lining membranes only, an infection of the comb and wattles without false membrane formation, or a mixture of both.

The most common form in Ontario is that in which the mucous membranes are attacked, with sometimes a few cases developing scabs on the comb and wattles at the same time. Pure scab formation is rare.

This disease causes heavy annual losses due to actual loss of birds and interference with laying. Following exhibitions losses are occasionally very high among the birds that were exhibited, and if they have been placed back in the flock without a period of quarantine, whole flocks have been wiped out.

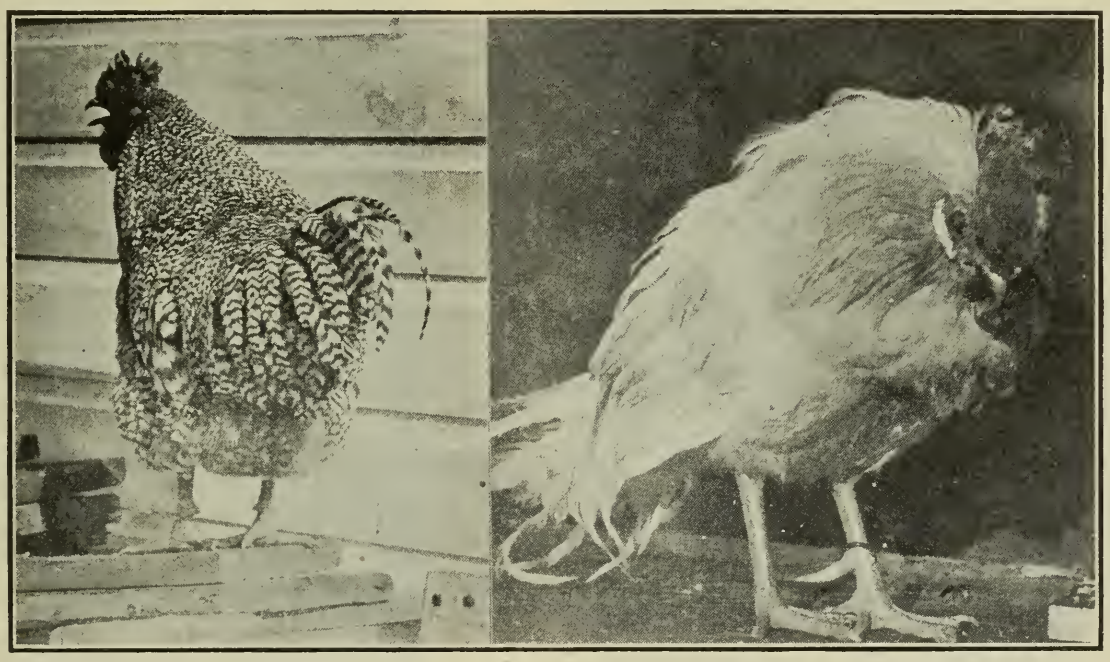

Fig. 5.—Two cases of avian diphtheria. (Original.)

Symptoms. These commence as with colds and roup. There is dullness, fever, sneezing and coughing. The eyes are watery. Occasionally they swell and become stuck together, as in roup. The sacs under the eyes may swell. An offensive smell is seldom present. The birds become very indifferent to their surroundings. Diarrhea is frequently present. The birds show difficulty in breathing, and bubbling noises are heard. There may or may not be a nasal discharge. While watching a flock, a bird may fall down, struggle violently and die, death being due to suffocation from stoppage of the larynx or windpipe. Yellow cheesy masses may be found in the mouth and in the larynx, but are not always seen in acute cases. An eruption on the comb and wattles may appear in the form of small nodules from the size of a pin head to a pea, or larger. They occur mostly around the nostrils and eyelids.

Period of Incubation and Duration. Symptoms may appear from three to fifteen days after exposure to infection and birds may die within two or three days after developing symptoms or may live for a week or ten days. We have on several occasions had birds die six days after having been placed with infected birds. Death in these cases was due to suffocation from the mass of exudate in the larynx or low down in the windpipe.

Post-Mortem Appearance. In acute cases that have died with only slight symptoms, the windpipe is intensely inflamed and filled with a thick, sticky reddish-gray exudate and often clots of blood, completely stopping up

the windpipe. In other cases a large yellowish mass may be found obstructing the larynx or windpipe (Fig. 7), and similar patches may be seen in the mouth and on the tongue. Wart-like nodules may be present on the comb or wattles, and in some cases on the skin. They are yellowish at first, becoming dark brown or black as they develop into a hard dry scab.

TREATMENT. Affected birds should be isolated in comfortable, well-ventilated quarters. At once examine those showing great difficulty in breathing.

Fig. 6.—Chicken-pox scabs on comb. (Original.)

Fig. 7.—Masses of cheesy exudate in larynx, windpipe, and on the tongue. (Original.)

In many such cases a plug of material can be picked out of the entrance to the windpipe with fine forceps, or a suitable piece of wood, or bone crochet-hook, giving the birds immediate relief. In other cases the stoppage is too low down to be seen.

The flock should be given one-half teaspoonful of salts per bird twice a week. Potassium permanganate at the rate of one-third teaspoonful to each gallon may be added to the drinking water. Cheesy patches in the mouth should be removed and the sore places touched with tincture of iodine. Scabs on the head should have oil applied and be allowed to soften for a few hours, after which the scabs should be washed off with warm soapy water and iodine similarly applied.

If the eyes or nose are affected, or swellings occur under the eyes, treat them as already described under the treatment for colds. Steaming with turpentine or eucalyptus oil is beneficial if the birds are not to be placed in cold quarters

afterwards. This can be done by placing them in a large box or small room where they are exposed to steam produced by boiling a kettle of water containing a little turpentine or oil of eucalyptus. Houses should be thoroughly disinfected after removing birds, and when the attack is over.

VACCINATION. In some experiments we carried out with a vaccine prepared from chicken-pox scabs, as advocated by Beach in California, it was shown that vaccination is of value in checking an outbreak of avian diphtheria. Losses were reduced, vaccinated birds recovered more quickly than the unvaccinated, and the spread of the infection among the healthy birds was checked. Vaccination in the fall, with the object of preventing an outbreak later, was not successful.

PREVENTION. Preventive measures for avian diphtheria are the same as described for the prevention of roup.

IMPACTION OF THE CROP (CROP-BOUND)

Impaction of the crop may be due to loss of tone in the muscular walls from some disease or from overdistention with dry grain, to mechanical stoppage with feathers, or commonly dry grass, which prevents the crop from emptying. It may also be due to small stones, buttons, etc., acting in the same way. Many cases in a flock point to some error in feeding.

SYMPTOMS. Loss of appetite or difficulty in swallowing. The crop is noticed to be distended, and on handling it is found to be quite firm. A bad smelling fluid may be occasionally brought up. Interference with breathing may occur from pressure, especially in waterfowl, or the bird may die from exhaustion.

TREATMENT. If the crop appears to be packed with grain a little oil may be given and the crop massaged to mix it among the contents. Then, holding the bird upside down, try and work the material back through the gullet. In the case of fibrous material the crop must be opened, the contents removed, washed out and sewed up. An incision from one to one and half inches is usually sufficient, and is made with a sharp knife, after plucking out a few feathers and painting with tincture of iodine. Insert a finger to make sure that all material has been removed. The incision should be closed with three or four stitches in the crop wall, and also in the skin. These sutures should be interrupted, that is, made and tied separately. Fast for a day or two, and then give soft food, such as bread and milk, for a few days. If the case is not too old, nor due to some other condition, recovery is usually rapid. One very bad case of perforated crop with extensive destruction of tissue that was operated on at the College made a good recovery, though the crop was only half the original size, owing to the amount of dead tissue removed.

INFLAMMATION OF CROP, STOMACH AND INTESTINES

These conditions are considered together, as frequently all the alimentary tract is affected at the same time. The inflammation may be due to various causes, as infectious diseases, mouldy or bad food, mineral irritants such as salt, lime and paint, or worms. Impaction of the crop, stomach, or gizzard may occur in some cases with the inflammation. We have seen impaction of the stomach and acute inflammation due to digestive derangement from poisoning with worm seed mustard and tape worm infestation.

SYMPTOMS. Dullness, indisposition to move, weakness, loss of appetite. There may be constipation, or if the intestines are affected, diarrhea. If in

the crop there may be distention and belching of gas. On manipulation a gassy liquid may be forced out of the mouth.

TREATMENT. The first thing is to find and remove the cause. If the crop is distended it can be emptied by holding the bird head downwards and gently

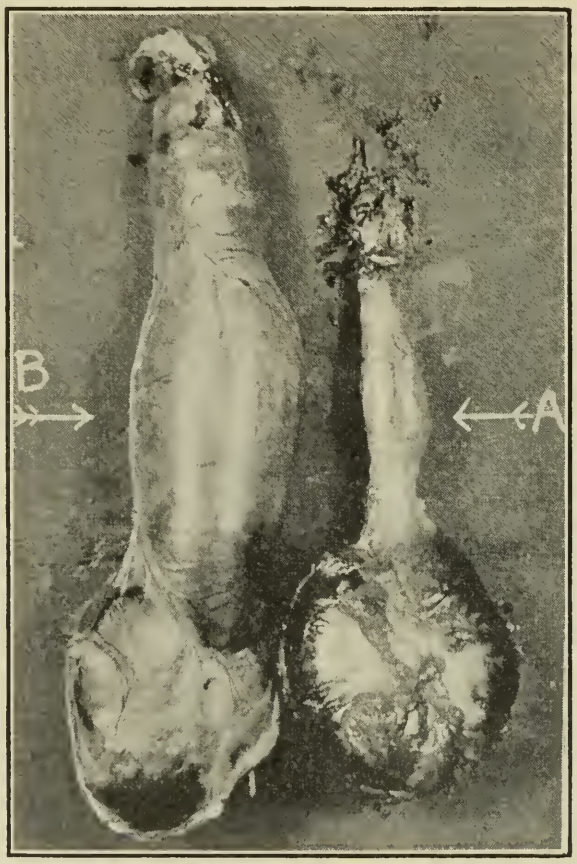

Fig. 8.—A. Normal stomach of fowl.
B. Severe impaction and inflammation due to digestive derangement from tapeworms in small intestines. (Original.)

massaging out the contents. Then give a little water and repeat the process. Epsom salts one-half teaspoonful, or castor oil one or two teaspoonfuls per bird should be given, and only a small quantity of soft food allowed.

SIMPLE DIARRHEA

Diarrhea is present in most of the infectious diseases. It may also occur from eating mouldy or decomposing feed, sudden change in feed, too much green feed, old dirty water, too much meat scrap, and irritants of various kinds.

TREATMENT. Endeavour to find and remove the cause. Give one-half teaspoonful of Epsom salts for each bird in a mash.

FOWL CHOLERA

Fowl cholera is an infectious disease that is rapidly fatal to all domesticated birds without regard to age. It is caused by a germ, *Pasteurella avicida*, which multiplies very rapidly in the blood and internal organs of affected birds. It is spread by sick or recently recovered birds introduced into a flock. It may also be introduced on the boots, clothing, utensils, or on animals that have been on infected premises. The droppings of affected birds contain enormous numbers of the germs, which are picked up by the others while eating and drinking. In this way the infection spreads very rapidly.

Symptoms. In very acute cases the birds are found dead, no previous sickness having been noticed, or they may be seen to fall dead while moving about. In such cases a flock may be almost wiped out in a week.

In less acute cases the first symptom noticed is the yellow colour of the droppings, due to the change in colour of the urates. Birds lose appetite but are very thirsty. They may go off by themselves and sit in a very droopy manner with the head turned backward or under the wing. The feathers are ruffled and the bird may tremble. When they move it is with unsteady gait, and the wings and head may droop.

Diarrhea develops early. The droppings are at first grayish-yellow and mushy, becoming very fluid and dark green, or reddish-brown with flakes in it and very bad smelling. Breathing is noisy, and a foamy liquid may drop from the beak and nostrils. Comb and wattles may be purple. Stupor overcomes them as the disease progresses and they lie with closed eyes, dying in this condition, or in convulsions.

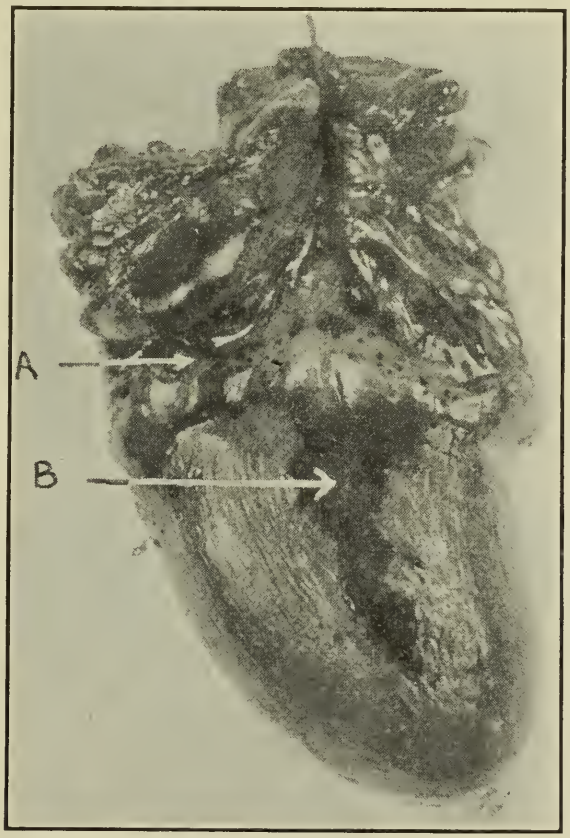

Fig. 9.—Duck's heart showing hemorrhages due to cholera. A. Band of small hemorrhagic spots. B. A large hemorrhagic area.

Incubation Period and Duration. The first symptoms may appear from four to nine days after infection has occurred, and in some cases a shorter period. The duration of the acute form is usually from one to three days.

Chronic Form of the Disease. A chronic form may appear among fowls, especially after an acute attack. In this case the acute symptoms subside, leaving the bird anemic and with a persistent diarrhea. There may be no acute symptoms, the attack commencing with diarrhea, anemia and emaciation. Leg or wing joints may swell and finally break, discharging a caseous purulent mass. After one outbreak investigated by us, an apparently healthy bird developed wry neck was killed, and on *post-mortem* examination pus containing *Pasteurella avicida* was found under the covering membrane of the brain.

Post-Mortem Appearance. On removing the skin the blood vessels of the skin of the breast and neck are full of blood and prominent, and the skin itself appears reddened. The heart shows the most constant changes, having small or large red spots or hemorrhages on its surface. The lungs may be brownish red in spots. The first portion of the small intestine may be swollen and studded with small red spots, or there may be larger reddened areas. The liver and spleen may be enlarged. The blood vessels of the various organs are congested.

In the chronic form yellowish-gray, dry patches may be present in the lungs, liver and lining of the intestines; also under the lining membrane of the heart. The serous lining of the chest and the heart sac may also be affected, and there may be a cheesy exudate in the affected joints.

Control. No treatment seems to be of benefit to affected birds, and attention should be focused on preventing the spread of infection. Remove and burn, or bury deeply, the bodies of the dead birds. Move healthy ones to new quarters if at all possible; but if this cannot be done, kill and dispose of sick birds, and clean and disinfect the houses and runs frequently. In either case watch the birds closely and at once remove any more showing the least signs of disease. Add one-third teaspoonful of potassium permanganate to each gallon of drinking water to prevent infection spreading in this way. Keep droppings cleaned up as they are the principal source of infection. If the birds can be kept in small groups the disease is more easily controlled.

EDEMA OF THE WATTLES

This is an infectious disease of a chronic nature involving the wattles. It appears to be a localized, chronic form of disease produced by the organism that causes fowl cholera. While not common, two outbreaks were investigated last year and the same organism recovered. Infection probably enters through

Fig. 10.—Front and side view of infected wattle. (Original.)

injury of the wattles due to scratches or fighting, probably the latter, as cockerels were principally affected.

Symptoms. One or both wattles become swollen and hot. On examination a small injury is noticed. On opening the wattle a clear gelatinous fluid runs out. In older cases a cheesy substance is present, and finally the wattle becomes permanently enlarged and wrinkled in appearance. In the cases investigated the health of the fowls was reported not to be affected, but cases have been reported of general illness and death.

Treatment. Cropping the affected wattles is the most satisfactory method.

FOWL TYPHOID.

Fowl typhoid is an infectious disease attacking the blood and internal organs of fowls and is due to a germ, *Bacterium sanguinarium.* Infection is brought into a flock just as in the case of fowl cholera, but the mortality is not as high as in that disease.

Symptoms.—Drowsiness, fever, loss of appetite and general weakness. The head may be held close to the body or hang limp. Mucous membranes of the head are pale. The comb and wattles are usually paler, but may in some cases be darkened. The blood is paler in colour than normal.

Incubation Period and Duration.—The first symptoms may appear four to six days after infection, and in fatal cases may last from four to twelve days.

Post-Mortem Appearances.—On opening the bird it appears paler than normal. The mucous membrane lining the intestines is pale. The blood is pale red in colour and does not clot readily. The liver is very large and covered with grayish spots. The spleen is usually swollen, soft, and filled with grayish spots. The kidneys are enlarged and paler than normal, or may be slightly reddened with blood.

Treatment and Control.—Exactly the same applies to this disease as to cholera. Treatment is unavailing, and sanitary measures as outlined for that disease must be applied to control the outbreak.

WHITE DIARRHEA IN CHICKS

The name white diarrhea has been applied to a number of diseases that may affect chicks from time of hatching until they are about a month old, and indicates the most common symptom observed. The important diseases causing a white diarrhea are considered under bacillary white diarrhea, coccidiosis, aspergillosis (brooder pneumonia) and fowl cholera. Feeding and temperature are sometimes responsible for the condition. The symptoms are much alike in all. Bacillary white diarrhea is the most fatal, with deaths occurring soon after hatching. Coccidiosis usually appears later and the mortality is also high. Brooder pneumonia is not as common but causes heavy losses at times in baby chicks, and a white diarrhea is commonly present in the last stages. Chicks may become infected with the organisms causing fowl cholera from some chronic case and suffer from a fatal white diarrhea.

BACILLARY WHITE DIARRHEA IN CHICKS

Bacillary white diarrhea is an acute, highly fatal disease of young chicks due to a germ, *Salmonella pullora* (*Bacterium pullorum*). Infection may occur in several ways. The most common source is infected eggs. The bacteria

may remain in the body of recovered chicks and later, if infection of the ovary takes place, they may pass into the eggs. Many infected eggs fail to hatch, but should one or more chicks be hatched harbouring the disease, the others are exposed early and become infected. Infected incubators and brooders, and day old chicks are also spreaders of infection.

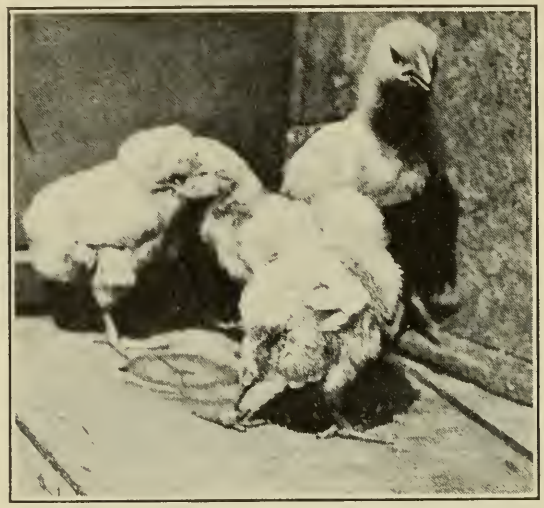

Fig. 11.—Bacillary white diarrhea in chicks. (Poultry Dept., O.A.C.)

Symptoms. The disease appears from a day or two after hatching until the chicks are three weeks old. Affected birds are drowsy, listless, ruffled and droopy. They sit or stand in the same position, and may sway when standing. Appetite is diminished. Droppings are white and creamy, sticky and shiny, or may be mixed with a brownish material. The passage of droppings often causes pain, as evidenced by a sharp cry of distress. The sticky droppings collect on the down, and may accumulate to such an extent as to plug the vent, in which case the chick soon dies. In any case the chicks become weaker, breathing becomes difficult, and they sit or lie with outstretched wings until they die. The mortality may run from forty to ninety per cent., and those that recover are usually unthrifty.

Incubation Period and Duration. The length of time after infection that symptoms appear is variable, and may be from a day or two up to ten days. Chicks usually die a day or two after symptoms develop, but occasionally develop a more chronic form.

Post-Mortem Appearance. The most constant finding is an unabsorbed yolk, though this may be found in very young chicks that have died from other causes. The liver may be a yellow colour and show dark patches due to congestion. The lungs may show small necrotic spots. Sometimes in the more chronic cases no changes are observable.

Treatment. No success is met with in treatment, nor is it desirable, as those birds that recover may act as sources of infection to future hatchings. As a preventive measure, when the disease exists in a flock of fowls, permanganate of potash may be placed in the chicks' drinking water in sufficient quantity to give it a deep red colour. This may help to prevent the spread of the bacteria through the medium of the water, and possibly check its growth in the intestine. Buttermilk is also indicated, on account of the lactic acid it contains.

Prevention. It is not desirable to save recovered birds for breeders, unless for special reasons. Infected hens should be eliminated from the breeding flock. A large percentage of these can be detected by means of a blood test.

If it is desired to breed from an infected flock for the purpose of continuing a particular strain, the following procedure has been recommended: Incubator trays or shelves, of the pedigree type, are used, divided off into compartments to hold from 6 to 10 chicks. The divisions must be solid, preventing any contact of birds. They need only be used a day or two before the hatch is expected to come off. The chicks are kept in their compartments, and need not be fed for 48 to 72 hours. If symptoms develop the infected batch are removed. Trays may be removed to the brooder, or similar trays arranged in them. After 3 days the danger of infection is reduced to the minimum, and all the hatch may be allowed to run together. After removing an infected batch the hands must be disinfected before watering or caring for the others. Trays must be thoroughly disinfected after use.

BACTERIUM PULLORUM INFECTION IN HENS

Bacterium pullorum, as well as producing white diarrhea in chicks, is the cause of an infection of the ovary in hens. As already observed, recovered birds may remain infected, and such birds may lay eggs containing the bacteria, and so the life cycle is kept up.

Symptoms. As a rule no symptoms are noticed, and the condition of the ovary is only found on *post-mortem* examination. Outbreaks of bacillary white diarrhea in the chicks point to infection in the flock.

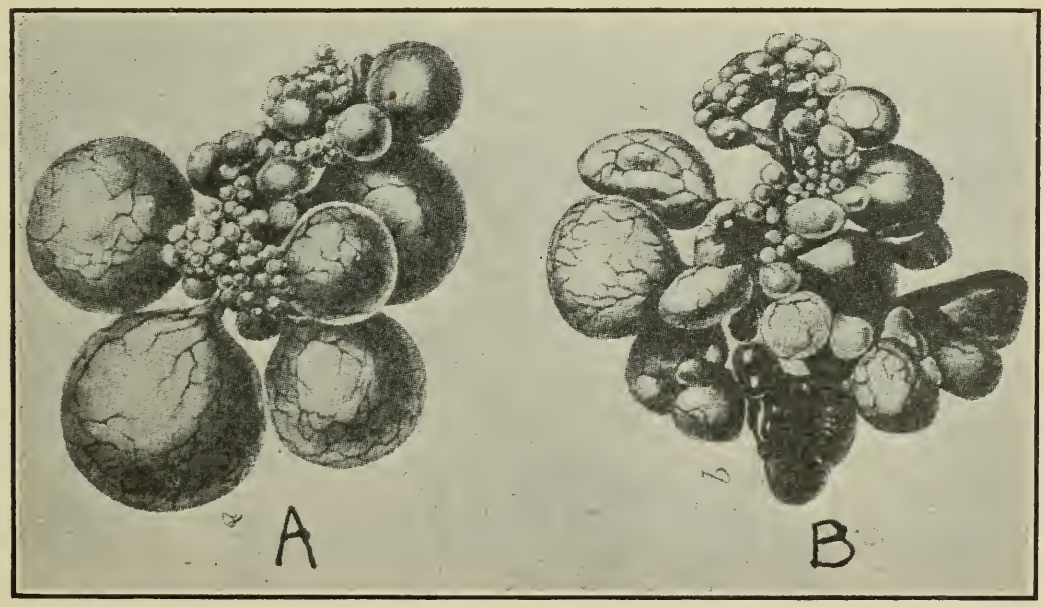

Fig. 12.—A. Normal ovary of hen. B. Infected ovary of hen. (Rettger.)

Post-Mortem Appearance. The ovary is usually the only organ to be found affected. The diseased ova are hard, shrunken and angular, and dark brown or greenish in colour. They may contain a dark fluid. Occasionally only slight changes are present. Sometimes small areas of infection may appear in the body cavities, as sac-like formations with yellowish, solid or fluid contents.

Diagnosis. The agglutination test is made use of to detect infected birds in breeding flocks. It is usually done after they are culled in the late summer

or fall. Blood is drawn from a large vein under the wing into a small test tube and allowed to clot. Band the hens and number the tubes correspondingly. At the laboratory the serum is collected from the blood and a small amount added to a cloudy suspension of *Bacterium pullorum*. The blood of healthy hens produces no change; while that of infected ones causes a clumping to occur in the suspension of bacteria.

COCCIDIOSIS

Coccidiosis is a disease of the intestinal tract of birds, and is caused by a protozoan parasite, *Eimeria* (*Coccidium*) *avium*. It attacks especially young chickens and baby chicks, being one of the causes of white diarrhea in the latter; but also causes disease in older birds, though these are more resistant.

The disease is transmitted by means of feed, water and soil that have become contaminated with the droppings of infected birds. Infection may be brought in with new birds or eggs, or by pigeons flying from place to place.

Symptoms. These depend upon the age of the birds attacked. In young chicks the symptoms are as described under bacillary white diarrhea. In some cases the droppings may be stained with blood. Birds under two months old seldom survive a severe outbreak, dying in a few days, and if they recover are usually stunted.

Older chickens have a stronger resistance, but the mortality is heavy with these. The disease is less acute in older birds. Droopiness, diarrhea, and periods of dejection are noticed. The comb and wattles are pale. After from 1 to 3 weeks in this condition the bird dies quite suddenly, or after a short period of coma.

In the more chronic form the bird becomes progressively weaker and emaciated. The appetite appears normal while the bird is eating, but the intervals between eating grow longer. A number of birds become thin, have diarrhea for a while and then recover.

Post-Mortem Appearance. In young chicks the ceca are filled with a bloody semi-solid mass and somewhat distended. In older birds the ceca are distended and hemorrhagic areas may be noticed. On being opened they are found to contain a solid mass, of a grayish colour and cheesy consistency. The mucous lining of the first part of the small intestine is reddened and hemorrhagic, and may be the only change seen in some cases. The liver may be enlarged and covered with gray or yellowish-white spots.

Treatment. One-third teaspoonful of crude catechu to each gallon of drinking water is kept before the birds. Also give unlimited buttermilk or sour milk. Continue treatment until signs of disease disappear. If the catechu produces constipation give salts in the mash in accordance with the size of the birds. Some recommend that bran mash should only be fed during an attack. For young chicks buttermilk is about all that can be given.

Prevention. Birds and eggs should be obtained from known healthy flocks. Unknown birds should be quarantined. Pigeons should be kept out. The organisms causing this disease are very resistant, and it is very difficult to clean up ground after an attack. Strong disinfectants are necessary. Houses should be thoroughly soaked with 5 per cent. compound solution of cresol. Runs should be limed and plowed under. It may be necessary to sprinkle occasionally with chloride of lime, as worms are blamed for bringing the organisms to the surface. They should be abandoned for a year if possible.

ASPERGILLOSIS (BROODER PNEUMONIA)

This is a disease of the lungs, air sacs and passages due to a common mould, *Aspergillus fumigatus*. It is inhaled by birds when scratching in mouldy straw and eating mouldy grain. It has been suggested that some outbreaks in brooder chicks may be due to the penetration of eggs by the mould. Only an occasional bird may be affected, or a serious outbreak may occur.

Symptoms. In chicks the symptoms are much like those of bacillary white diarrhea, and the chicks die within a few days. In older birds catarrh is followed by obstruction of the air passages, and breathing is noisy. Birds become weak, and remain by themselves. Diarrhea and fever are present, causing sleepiness and depression; and finally the birds suffocate. They may live from 1 to 4 weeks or more. If the air sacs only are involved there is weakness and loss of flesh. Involvement of the air sacs of the bones causes lameness and swollen joints.

Post-Mortem Appearance. Whitish or yellow patches are seen on the lining of the air passages in the early stages. Later mouldy growth is present. Other organs may be affected.

Prevention. Treatment appears to be useless. Avoid mouldy litter or feed. Burn or bury carcasses of affected birds.

TUBERCULOSIS

Tuberculosis is a chronic infectious disease of birds caused by a germ. *Mycobacterium avium*. Infection is usually introduced into a flock by bringing in a diseased fowl. Pigeons, which are quite often infected, or wild birds, may introduce the infection. Eggs from diseased birds may contain the germ, and if fed, as in the case of infertile incubator eggs, may spread the disease. A small percentage of infected chicks may hatch from infected eggs. Rats and mice may also become infected with the organism, and help to keep the infection alive. The droppings of infected birds contain the germs, which thus gain entrance to the body of healthy ones with the food, and on reaching a suitable location grow and extend to the different organs. After growth has progressed to a certain extent symptoms of the disease are manifested.

Symptoms. The disease is slow in developing, and symptoms are principally noticed in birds over a year old. They become very thin and wasted, the breast muscle almost entirely disappearing, yet are good feeders. Swelling of the legs and lameness are common, due to joint infection. The swelling may burst and discharge cheesy matter. In the later stages diarrhea is present, and the bird is dull and sleepy. Death may occur among members of the flock at fairly long intervals, and the presence of the disease may not be suspected.

Incubation Period and Duration. The disease is slow to develop, symptoms not being seen as a rule in young birds. Death may occur shortly after the development of symptoms, or birds may live for quite a long time.

Post-Mortem Appearance. The liver and spleen are most often affected. Grayish or yellowish-white nodules are scattered over, and sometimes project from, the surface. They vary in size from a lentil to a pea, and are sometimes as large as a hazel nut. These tubercles have a capsule of fibrous tissue, and when cut into may be gelatinous, dry and crumbly, cheesy, or occasionally

gritty. The liver and spleen are often much enlarged. The intestines are frequently infected, large or small nodules, appearing on and in them, similar to those in the liver. Infection of the lungs is less frequent, but occasionally large, cheesy, yellowish-white areas are found. Any of the organs may be infected. Diseased joints contain a yellowish, cheesy or crumbly material.

Prevention and Control. Nothing can be done in the way of treatment. The most satisfactory way to eradicate the disease is by killing off the flock and commencing with fresh stock, after thoroughly cleaning and disinfecting the houses, runs, utensils, etc. Birds in good flesh may be utilized for food. Diseased organs, and carcasses of badly affected birds, should be destroyed

Fig. 13.—Tuberculosis of liver, spleen and intestines. (D. H. Jones, O.A.C.)

Fig. 14.—Tuberculosis, showing emaciated condition of carcass. (D. H. Jones, O.A.C.)

by burning or burying. It is highly desirable to leave the runs without poultry for a year, or to commence again on fresh runs, where birds have not been kept for that period. New stock should be obtained from flocks where it is known that no infectious disease exists.

If this method is not adopted, the best thing that can be done to lessen losses in the average small poultry yard is to avoid keeping old birds; weed out suspicious cases; keep young stock separated, as far as possible, from the old infected flock; kill rats and mice; destroy carcasses of affected birds by fire or burying. Where fowls are raised under conditions in which those of various ages are isolated, the disease does not have much chance to spread.

Fuller particulars regarding this disease are given in Bulletin 255, Tuberculosis of Poultry in Ontario, by D. H. Jones, which can be obtained on application to the Ontario Department of Agriculture, Toronto.

ENTEROHEPATITIS (BLACKHEAD)

This is an infectious disease affecting turkeys principally. Young chickens are only slightly susceptible, but may act as carriers of the infection. A protozoan parasite is believed to be the cause of this disease. Infection occurs through the contamination of feed and water with droppings from affected birds or carriers. Certain investigators have shown that turkeys fed infective blackhead material and the eggs of the cecum worm, develop blackhead; but that the material fed without the worm eggs does not readily produce the disease. This points to the fact that these worms may play an important part in helping to set up infection, when the infectious agent is present.

Symptoms. Young turkeys are most often attacked, and usually during the fall; but the disease may occur at any time. Affected poults are drowsy and lack vigour. They are unable to keep up with the flock. There is loss of

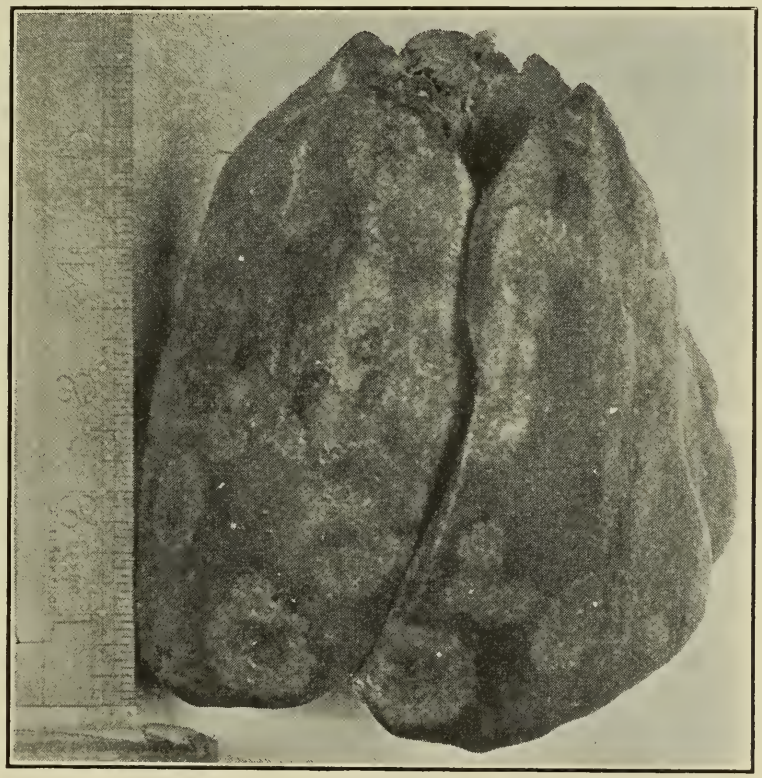

Fig. 15.—Liver of turkey showing lesions of blackhead. (Original.)

appetite, the feathers are ruffled and the wings droop. Diarrhea is usually present. The droppings are yellowish in colour, mixed with brown. In the later stages the head may become dark purple. The disease has been wrongly named after this symptom, as it is not constant, and is also found in other conditions where there is weakened heart action. Death may follow a few days after symptoms appear. In older birds, diarrhea, progressive loss of flesh and weakness are seen, and the disease may last for a couple of months, followed by recovery or death. The mortality is high in young birds, up to 90 per cent., but much less in older birds, perhaps 10 per cent. or more, according to the severity of the attack.

Post-Mortem Appearance. One cecum, or both, are thickened, and the ceca themselves distended with a dull, gray, crumbly or cheesy mass. (The ceca are the two blind guts.) The whole or only part of the cecum may be

involved. In the liver there are yellowish-green, round areas. They may be mottled with apparently normal liver tissue. They are not surrounded with fibrous tissue, nor so clear-cut as in tuberculosis, the areas seeming to merge into the liver substance.

PREVENTION. Treatment of diseased birds has not proved successful. It is suggested that putting catechu in the drinking water at the rate of ⅓ teaspoonful to the gallon, for the first three months, might bring exposed poults safely through the dangerous period. Salts must be administered if this treatment produces constipation. The birds should be treated for worms, in view of their possible connection with the disease.

In some districts it is almost impossible to raise turkeys without taking special preventive measures. The following outline has been advocated for use under such conditions: Obtain eggs from birds believed to be healthy. Wipe the eggs with a clean cloth wet with denatured alcohol (80 to 90 per cent.) before they are placed in the incubator, or under the hen, for hatching, to remove any contagion that might be on the shell. Hatch in an incubator, or at least remove the eggs from under the hen a day or two before hatching, wipe with alcohol, and finish in an incubator, in order to avoid exposing poults to the hen. Place the young poults in a brooder on inclosed ground at a distance from all other domesticated fowls, and not recently occupied by other fowls. Exclude, as far as possible, pigeons, wild birds, and rats and mice from the houses and runs occupied by the turkeys. Frequently disinfect the houses, feeding troughs, drinking fountains, etc. Immediately kill diseased birds and burn the bodies. The turkeys should be confined in the inclosure until grown, and given sour milk or buttermilk frequently.

LIMBERNECK

This is a symptom which may appear as a result of different conditions, such as ptomaine poisoning or botulism; and is associated with the eating of putrid meat, maggots, and spoiled food. The muscles of the neck are paralyzed, and the bird rests with its head on the floor. Before complete paralysis sets in the head may be raised, but soon drops down again.

TREATMENT. One-half teaspoonful of salts or two teaspoonfuls of castor oil for mature birds. When due to botulism, antitoxin has been utilized, but at the present time its use is impracticable owing to the difficulty of diagnosing the condition.

Fig. 16.—Wry-neck due to intestinal inflammation from tapeworms. (Original.)

WRY-NECK

In this condition the neck, instead of being limp, is drawn to one side, or backwards, and the head may be twisted around so that the bird is looking

upwards. More or less violent spasms may occur. Wry-neck may be due to intestinal irritation or some brain condition. We have found it most frequently associated with inflammation of the mucous membrane of the small intestine due to minute tapeworms, to tumours affecting the brain, and in one instance to an abscess under the covering of the brain caused by the fowl cholera organism.

Treatment. Purgative medicine, as in limberneck. We have not found worm treatment to do any good at this stage, though the presence of the worms has been demonstrated. The treatment as outlined under Tapeworms should be applied to the rest of the flock if the condition is due to parasites.

GOUT

Gout is due to deposition of urates in the internal organs or joints, and may be produced by too much meat, in conjunction with lack of exercise; or by disease of the kidneys and ureters. Experimenters produced gout in birds by feeding them for months on horse meat. In one flock, where a number of birds were affected with visceral gout, we found that they had had access to the partially buried carcass of a horse for more than a month, and in addition were receiving a large quantity of tankage in their mash. The three or four birds that were killed and examined showed heavy gouty deposits in the body.

Symptoms. The condition may appear in two forms; visceral gout, affecting the internal organs only; and more rarely articular gout, in which the joints become swollen. When the internal organs only are affected, the comb and wattles are pale; the bird is droopy, weak, and emaciated. There is nothing distinctive by which this form of the disease can be recognized until the bird is examined after death.

In the articular form the joints of the feet and legs become swollen and painful. The swellings may break and discharge a yellowish-gray material. Deformity of the feet occurs due to the swellings.

Post-Mortem Appearance. In visceral gout the organs, and serous membranes lining the body cavities are covered with a white powder composed of crystals of urate of soda. The kidneys are sprinkled with white spots, and the ureters may be plugged with the same material.

In the articular form the swellings contain chalk-like deposits up to the size of a cherry, and similar masses may be found in the adjoining bone, marrow, tendons and blood vessels, or under the skin.

Treatment and Prevention. If several birds develop this condition give all a dose of salts, reduce the meat supply, and give plenty of green food. Enlarged joints may be opened and washed out. Prevention consists of giving plenty of green feed and not too much meat.

LEG WEAKNESS

Leg weakness of fowls is a condition that is not fully understood. It may appear in conjunction with tuberculosis, infestation with worms, rachitis, and inflammation of the oviduct. Apart from this we have observed two distinct types in otherwise healthy birds.

One type occurs in pullets during the months of heavy egg production, and is believed to be due to interference with the nerve supply of the legs, from large eggs, or irritation, induced by temporary stoppage of the egg in the oviduct. Support is lent to this by the fact that birds usually recover shortly

after laying. They appear strong and healthy, but are unable to rise, and struggle violently when approached. Recovery usually takes place within a couple of days without treatment. Birds should be placed by themselves and

Fig. 17.—Leg weakness due to parasites. (Original.)

given ½ teaspoonful of salts. If the condition persists longer than 3 or 4 days recovery does not usually take place, and it is best after this time to kill the bird while in good condition.

The other type occurs in birds confined to fattening pens. These cases are also in good condition and are very full-blooded. Change of diet, salts,

Fig. 18.—Leg weakness in cockerel in fattening pen. (Original.)

green feed, and release from the pen may effect a cure. Many cases stubbornly resist treatment of any kind and after a few days it is better to kill them while in good condition.

VENT GLEET

This condition is described as an infectious venereal disease of fowls. Our experiments to transmit it from fowl to fowl have been unsuccessful, even when material from infected birds was scratched into the mucous membrane of the cloaca of others. It appears probable that it is due to irritation of some sort, though our work has not been extensive enough to exclude the possibility of its being infectious under certain conditions, and for this reason affected birds should be isolated.

Symptoms. Inflammation of the cloaca occurs. The skin around the vent is swollen, red and sore, and may become ulcerated, owing to the bird

pecking the irritated parts. A yellowish-white discharge collects about the vent and has a very bad odour. Droppings are voided frequently and are sometimes watery.

Treatment. This is slow, and probably not worth while attempting except in a valuable bird. We have found the following to be as satisfactory as any tried: Cleanse the vent with warm, soapy water. Inject about 2 ounces of 1 per cent. potassium permanganate solution once a day (or better twice) into the cloaca by means of a funnel and piece of rubber tubing. Anoint the external parts lightly with zinc oxide, or any other healing ointment.

EGG BOUND

Inability to lay an egg is of frequent occurrence in fowls, especially when beginning to lay. Probably the most common cause is the attempt to lay a large egg before sufficient dilation of the oviduct has occurred. It may also be due to inflammation, malformation, and tumours, or an abnormally large egg.

Symptoms. Frequent efforts are made to lay. The straining causes inflammation, and in bad cases the oviduct may be everted through the vent, or may rupture. If relief is not obtained death may occur from exhaustion.

Treatment. No treatment should be attempted until evident that the bird will not lay naturally. Then pour some olive, or other oil, into the cloaca, and with one finger inside and the other hand outside, endeavour to bring the egg out. The greatest care must be taken to avoid injuring the fowl. In cases where the egg cannot be delivered it may be broken with a blunt awl or nail, the contents and all shell carefully removed, and the cloaca flushed out with cold water.

YOLK CONCRETIONS

Hard masses of yolk material, yolks, or imperfectly formed eggs are sometimes found in the abdominal cavity. They do not produce symptoms unless they collect in large quantity, causing dropping of the abdomen; or becoming infected, give rise to peritonitis. Sometimes nothing can be seen to account for the condition. At other times it may be due to obstruction or injury to the oviduct, causing a reverse movement which carries the egg back into the abdominal cavity. As the condition is not as a rule recognized during life, operative treatment cannot be tried; and even if the material were removed the cause would still be present, permitting the trouble to continue.

PERITONITIS

Peritonitis is an inflammation of the serous coverings of the organs in, and the lining of, the abdominal cavity, It is caused by bacteria, and may occur with certain infectious diseases, or be due to infected yolk concretions, extension of inflammation from other organs, or injury to the intestine.

Symptoms. There is nothing to distinguish this condition from a good many others, and consequently the trouble is not usually found until after death. The bird shows loss of appetite, dullness, fever, weakness, and probably diarrhea. If yolk concretions are felt in the abdominal cavity peritonitis would be suspected.

Post-Mortem Appearance. On opening the bird a clear or cloudy fluid may flow out of the abdominal cavity. The membranes are dull and opaque instead of being bright and glistening. There may be a cheesy exudate in

masses between the organs. Decomposing egg yolks or foreign matter may be noticed if the infection has arisen from these sources.

TREATMENT. No treatment is practicable, as the condition is seldom recognized during life.

TUMOURS

Tumours of various kinds occur in fowls, and may cause loss of condition and death. They are sometimes found in apparently normal birds when killed. They are seen principally in mature and old birds. The female reproductive organs and the liver are the organs most commonly affected. Tumours occurring on the surface of the body can be recognized, but when affecting the internal organs the condition cannot be differentiated from certain others.

Fig. 19.—Tumour on larynx of fowl. (Original.)

Fig. 20.—Tumour on wing of fowl. (Original.)

POST-MORTEM APPEARANCE. The organ or part is usually increased in size, and is frequently very irregular in shape, having large or small nodules, or it may have large protuberances.

A microscopic examination is necessary to decide upon the nature of the tumour. If this is desired, a small piece of the growth should be placed, when fresh, in a small wide-mouthed bottle containing 10 per cent. of commercial formalin in water, and sent to the laboratory for examination. Only a small piece of the growth is necessary.

TREATMENT. Nothing can be done unless the growth is external, when it can be removed. If of a malignant nature this would not help, as it would probably recur.

LEUKEMIA AND PSEUDO LEUKEMIA.

Leukemia is fortunately not common enough to be of economic importance. It is a disease that is manifested by changes in the blood and blood producing organs. Usually only a single bird in a flock is affected.

Symptoms.—The bird is emaciated, dull and weak. The abdomen may droop. Appetite is usually good. Comb and wattles are pale on account of the lessened number of red blood cells and the increase in white blood cells. The blood is pale and slow to clot. In acute attacks, death may occur suddenly.

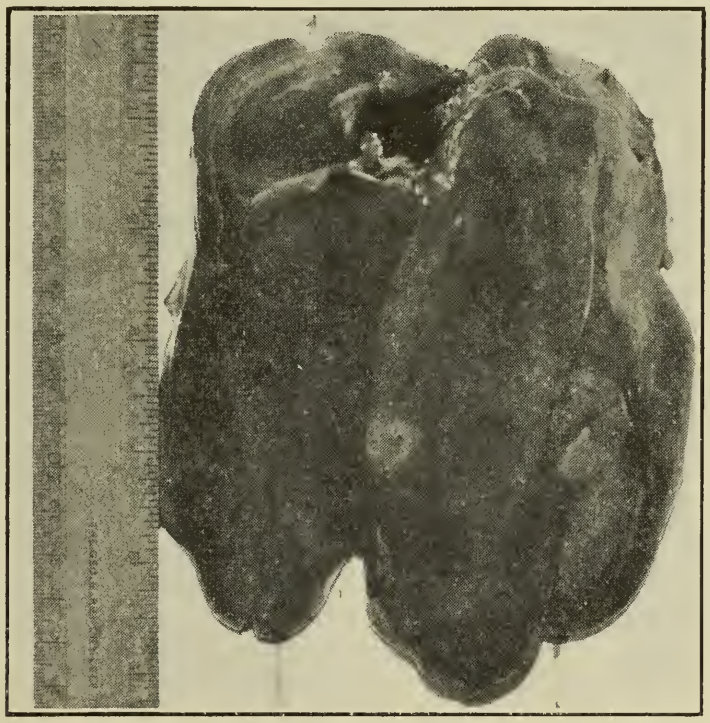

Fig. 21—Liver of hen, showing lesions of leukemia.

Post-Mortem Appearances.—The carcass appears pale. The liver and spleen show most marked changes. The kidneys may also be involved. The liver may be slightly larger and dotted with minute white points, or very large and pale and covered with gray spots. The spleen is usually enlarged and shows similar changes to the liver. The kidneys may be several times the normal size. The intestines are pale, but there may be reddened areas on the lining of the small intestine.

Pseudo Leukemia.—This condition resembles leukemia in the changes in the organs, but the change in blood cells does not occur. Both conditions may be confused with fowl typhoid, tuberculosis, new growths and coccidiosis.

Treatment.—The condition is not usually recognized until after death and in any event treatment is not effective. Destroy the affected carcass.

BUMBLEFOOT

This term is applied to an injury of the foot when germs gain entrance through a cut or bruise, causing a swelling which contains a liquid or cheesy material. It may be caused from a bruise due to jumping from a high perch.

Treatment. If there appears to be an abscess it should be opened and washed out, some tincture of iodine injected, and the foot bandaged. Remove the perch until the foot is healed.

POISONING

Poisoning may occur from birds eating putrid or mouldy food, certain weed seeds, or mineral poisons that have been left around. We recently investigated the loss of 5 geese that died from eating a large quantity of the seeds of wormseed mustard (*Erysimum cheiranthoides*). The carcasses smelt strongly of mustard on opening, and an acute inflammation of stomach and intestines was present. In one case the stomach was impacted with the mixture of grain and weed seeds, and highly inflamed. Rose chafers are reported to be poisonous to chickens up to 10 weeks. They devour them readily and only a few are necessary to cause death.

Treatment. In a general way, the only thing that can be done is to remove the cause, if known, and give salts or castor oil to assist in eliminating the poison.

FEATHER PULLING AND EATING

Enquiries are frequently received regarding this condition, in which a bird will pull out its own or another bird's feathers. In some cases the feathers are merely pulled out, and in others are eaten. Feather pulling may be due to irritation from parasites, such as the depluming mite; or normal feathers erupting during moulting. The habit of feather eating may be acquired when birds are kept on a monotonous and too limited diet. We have observed both conditions in experimental birds confined in close quarters.

Treatment and Prevention. Cooked blood mixed with bran and curd has been recommended; also shell, and plenty of green feed, in winter sprouted oats or beets, and exercise. If due to parasites treat as described under that section.

TOE PECKING

This is seen in brooder chicks. Something unusual about the foot attracts the attention of another chick, which pecks at it. The others imitate its example and blood is drawn. The taste for blood is aroused and other chicks are attacked, sometimes with heavy losses. The vent may be pecked away in some cases.

Treatment and Prevention. Remove wounded birds promptly; give something to distract their attention. Various kinds of food, such as dried meat, hung high enough to be almost out of reach, keeps them occupied.

FAVUS (WHITE COMB).

This is a contagious disease caused by a fungus (*Achorion schonleinii*) and commences as a rule with the comb and wattles, but may attack the feathered part of the skin.

Symptoms.—Small white or gray, scaly patches appear on the comb and wattles. They increase in number and join together, covering the whole surface with dry, scaly, white crusts. The neck and body may be invaded with the growth and the feathers break off easily. Usually the disease is limited and may disappear without treatment.

Treatment.—Isolate affected birds. If the body is affected kill the bird and burn the carcass. If the head only is attacked, Tincture of Iodine or Calomel Ointment (calomel 1 part, vaseline 8 parts) may be used.

INTESTINAL WORMS

Fowls are more or less infested with worms, which when present in small numbers may do little harm, but in heavy infestations may cause heavy losses, both directly and indirectly. It should be remembered that slight infestations that are unchecked become serious through the birds picking up more eggs or larvae. Apart from the direct, harmful results of worms, which we believe are much greater than generally realized, the general condition of an infested flock is lowered, and they are more susceptible to other diseases.

Symptoms. The symptoms of roundworm and tapeworm infestation are very similar. The presence of a few roundworms does not produce any noticeable changes; but a comparatively small number of tapeworms may do so. In a moderate infestation the appetite may be ravenous and great thirst be manifested. If heavily infested the birds become weak and unthrifty; laying falls off, and the condition of the flock generally is poor. The feathers are ruffled, and the comb and wattles are pale. Digestive disturbances are indicated by diarrhea or sometimes constipation, and loss of appetite. Wry-neck is not infrequently seen, especially in tapeworm infestation, and leg weakness may occur in the later stages.

Post-Mortem Appearance. The intestines should always be opened at a *post-mortem* examination, and carefully washed out in a dark coloured pan of tepid water, when the worms can more readily be seen. Some of the tapeworms are too small to be seen without a microscope, and in these cases the small intestine, especially the first few inches, will be very red and inflamed inside. Nodules in the intestine are produced by one of the larger tapeworms, which closely resemble the nodules of tuberculosis. However, the presence of tape worms, attached to the nodules, and the absence of tubercles in the liver and spleen, differentiate it from this condition.

ROUNDWORMS

The two roundworms most commonly found in the fowl are a large white or yellowish worm, *Ascaridia perspicillum*, in the small intestine; and the cecum worm, *Heterakis papillosa*, found in the ceca or blind guts. The large roundworm measures from 1 to 4½ inches, and may be present in such numbers as to block the intestine. The cecum worm varies from 3/10 to ½ inch in length. The ceca are at times completely blocked with them and may be very severely inflamed.

Treatment. Many treatments have been suggested. We have found the following method, recommended by the Oklahoma Experiment Station for tapeworms, to be very satisfactory for the large roundworm and cecum worm in poultry: A gallon of a mixture of wheat and oats, to which is added a small tablespoonful of concentrated lye, is cooked slowly for about 2 hours, and allowed to cool. The birds are given their ordinary feed one morning, and then nothing else until the next morning, when they are given as much of the lye mixture as they will eat, with plenty of water. This should be done 2 or 3 times during the summer at intervals of a month.

Another method is to added 2 per cent. by weight of tobacco dust containing at least 1.5 per cent. of nicotin to the dry mash, and feed this to the flock for a period of 3 or 4 weeks. Oil of chenopodium at the rate of 1 teaspoonful to 12 birds in a moist mash has been recommended for the large roundworm.

In conjunction with treatment strict cleanliness and sanitation must be observed; the houses and yards being thoroughly cleaned and disinfected to

prevent reinfestation. If the birds can be moved to clean land after being treated it is even better. Failing this, the top soil, containing worm eggs, should be removed where the birds cannot get at it. Keep the land well drained. Damp land is more favourable to the parasites. Clean up the droppings frequently.

TAPEWORMS

These are white, ribbon-like, segmented worms, which vary in size from microscopic to those easily seen. The two we have found most commonly in fowl are a fairly large worm, *Choanotaenia infundibuliformis*, varying from ¾ to 9½ inches in length; and a microscopic one, *Davainea proglottina*, from 1/50 to 1/15 of an inch in length.

The life history of many of the tapeworms is not known, but with those that have been worked out it is known that the eggs passed out in the droppings are eaten by insects, slugs, etc., in which they hatch and go into the larval stage. If the insects are later eaten by the fowls, the larval forms again develop into mature tapeworms.

Treatment. We have found the lye treatment outlined for roundworms fairly satisfactory for tapeworm infestation. The same sanitary precautions are applicable and should be observed.

LICE (MALLOPHAGA)

Several species of lice are found on poultry. The whole life cycle is lived on the birds, so that when the lice are destroyed reinfestation will not take place from the house. Lice cause loss of weight, lower egg production, and general lowered vitality of the flock.

Treatment. Sodium fluoride is highly recommended by most authorities. While not very rapid, it is thorough, and it is claimed that one treatment is sufficient to rid the birds of lice, as it remains on them long enough to catch the young after they emerge from the eggs, which are not injured by the treatment. However, it seems advisable to us to repeat the treatment in, say, two weeks.

Pinch Method. Sodium fluoride can be applied by the pinch method, which consists of placing on the skin of each fowl approximately 12 pinches (the amount held between the thumb and forefinger) of commercial sodium fluoride, distributed on the breast, each thigh, below the vent, on each side of the back, on the neck, on the head, and one on the under side of each outspread wing. The excess powder is caught on a newspaper.

Dusting. Sodium fluoride can be mixed with 3 or 4 times its bulk of flour or road dust, and applied with a shaker, ruffling the feathers as it is applied.

Dipping. Dipping can be practised in warm weather, so that the birds will be dry before nightfall. One ounce of commercial sodium fluoride is dissolved in each gallon of tepid water. The body is held under the fluid for about half a minute, ruffling the feathers to let the liquid in, the head then ducked, and the bird held to drain for a few seconds.

Carbolic Dusting Powder. A very satisfactory powder is one originated by Lawry, of Cornell University Poultry Department, consisting of 3 parts of gasoline, 1 part of crude carbolic acid, 90 to 95 per cent., and sufficient plaster of paris to take up all the moisture. The liquid and the dry plaster are thoroughly mixed, until a dry, well-mixed powder is left. In some experiments tried this powder killed lice very quickly, the majority in 2 or 3 minutes, and practically all in 20 minutes. Sodium fluoride and sulphur were much slower in their

action, taking from 30 minutes to 20 hours to kill lice brought into contact with them. With sulphur none were killed before 2 hours, and some still alive at 20 hours.

PREVENTION. Dusting boxes, containing fine dust, to which can be added some lice powder, should be kept available. Treat all new birds before adding to the flock.

MITES

COMMON POULTRY MITE. The common poultry mite (*Dermanyssus gallinae*) hides in cracks and corners during the day, infesting the fowls at night for the purpose of drawing blood. For this reason its presence may be overlooked. Fowls in a heavily infested house become droopy and listless. Occasionally some mites remain on the birds during the day.

TREATMENT. Thoroughly clean chicken houses, removing and burning the straw, and spray with crude petroleum diluted with 1 part of coal oil to 4 parts of crude oil. The oil should be allowed to soak unto the wood before the birds are returned to the house. With this heavy preparation one application is usually sufficient. Coal oil or carbolic acid are effective, but lacking body, they must be repeated several times at 10 day intervals.

SCALY LEG MITE. The scaly leg mite (*Cnemidocoptes mutans*) burrows under the skin of the legs, causing enlargement and roughness. The scales are pushed up by a crusty substance and project straight out, producing the roughened effect. In severe cases the joints may be inflamed, the birds are lame, and a joint, or whole toe, may be lost. The birds may die of exhaustion from inability to scratch feed. The condition is transferrable to the other birds, but does not spread readily.

TREATMENT. Infested birds should be isolated. Wash the feet and legs with warm soapy water and remove loose scales. Apply an ointment made of oil of caraway 1 part and vaseline 5 parts. Many other remedies have been advocated, but this appears to be as satisfactory as any.

FEATHER MITE (*Tropical Mite*).—The feather mite (*Lyponyssus bursa*) is a new pest, having been reported about two years ago in Ontario. They differ from the common poultry mite by remaining on the birds practically all the time. Occasionally they are found on detached feathers in nests. The adult mites look like black specks, and when they come out on the feathers of a badly infested bird on a sunny day they make it look as if sprinkled with pepper. They are most commonly seen around the vent, but may be found anywhere among the feathers. They are very resistant to cold and starvation and may live many days when separated from a bird. They suck blood and when abundant, as they will become if the birds are not treated, they cause the fowls to become very droopy, and may even lead to their death.

TREATMENT.—Thoroughly clean out the houses, burn litter and nest material, and spray with a mixture of crude oil and coal oil as described under the treatment for the common poultry mite. Crude oil can be obtained from any of the large oil companies. Coal oil alone, creosote oil, or any of the coal tar products can also be used. Treat each bird by dusting heavily with sulphur. It is a good plan to use one part of sodium fluoride to four parts of sulphur, as this mixture will also be effective for lice.

DEPLUMING MITE. The depluming mite (*Cnemidocoptes gallinae*) may cause loss of feathers in birds during the spring and summer. It attacks the portion of the feathers beneath the skin. The feathers may be shed, or break off close to the level of the skin. The stumps may be cracked, and surrounded

with scaly material. The mites may be observed on the stumps of the quills. The irritation caused may set up the habit of feather pulling. In severe cases egg laying may be interfered with, and the birds become emaciated and may die.

TREATMENT. Affected birds should be isolated, and sulphur ointment, or oil of caraway ointment, applied to the affected parts.

AIR SAC MITE. The air sac mite (*Cytoleichus nudus*) is just large enough to be seen with the naked eye. They may be found in the windpipe, lungs, air sacs, hollow bones, and the peritoneum. They are most commonly found in the air sacs. They do not appear to be harmful, for they may sometimes be found in large numbers in healthy birds. No form of treatment has yet been found for this mite.

CONNECTIVE TISSUE MITE. The connective tissue mite (*Laminosioptes cysticola*) is most found under the skin in places where it is loose, such as the flanks, breast and neck. In yearling and older birds small white granules are observed, which are composed of lime salts that have been deposited round the parasites, as a reaction of the body against them. They are mostly seen in old fowls in poor condition, and apparently do no harm. Sometimes the condition is confused with tuberculosis, for which reason the parasite is mentioned here, as fowls affected with these white granules are quite suitable for food purposes.

ACKNOWLEDGMENTS

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Cold Storage on the Farm

Its Value and How to Provide for It

By

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TORONTO, ONTARIO, OCTOBER, 1924

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

(A revised edition of No. 207.)

COLD STORAGE ON THE FARM.

By R. R. Graham, Associate Professor of Physics.

NATURE AND PURPOSE OF COLD STORAGE.

As ordinarily understood, cold storage is the practice of storing perishable farm products like meat, milk, cream, fresh fruits, butter, eggs, etc., in cold air rooms with the object of preserving them in good condition until they are required for consumption either at home or abroad. Low temperature, of course, is the most essential condition for keeping these articles of food in storage, but there are other important conditions, too, namely, pure and sweet air, circulation, ventilation, and humidity or degree of moisture If all these conditions are maintained in a cold storage, perishable products will keep surprisingly well for a considerable time, depending on the kind of products stored, provided they are in prime condition when stored and properly packed in the rooms. The greater the quantity of goods stored together, either all of one kind or several kinds, the greater the need for having all the conditions mentioned above properly adjusted; but even in a small storage they must be carefully provided for.

Its Value.

(To people generally and farmers in particular.)

The practice of cold storage has been in use long enough in this and other countries to justify the following statements regarding its value to any nation.

(1) It extends the life of perishable products.

(2) Hence they are available for use as food for a greater length of time each year.

(3) There is likewise much less loss by decay and waste.

(4) Greater quantities of them are consequently used, and hence, more is produced.

(5) People can enjoy a greater variety of food throughout the year, and many foods out of season.

(6) It is possible to transport perishable products long distances by rail and steamboat, the products being cooled down to a low temperature at the point of production in cold storage rooms and kept cool in refrigerator cars in transit.

(7) Markets of the world are supplied with a more uniform supply of foods throughout the year.

(8) Consequently prices are maintained at a more uniform level from season to season.

(9) So-called "gluts" of the markets are largely prevented, because the cold storages take care of the products when the production is large and bring them on the markets later when the production falls off or ceases altogether.

(10) If such storages were accessible to farmers, particularly dairy and fruit farmers, they could market their products at will and avoid sacrificing them on glutted markets at low prices as is too often the case.

(11) It enables the producer, wholesaler and retailer to put a better quality of goods in the hands of the consumers from day to day.

(12) Its value to the farmers directly lies chiefly in providing an efficient means for cooling milk and cream and maintaining them in a sweet condition for a few days; for instance, over week ends, and in making possible the use of a household refrigerator, which is very useful in saving foodstuffs and keeping them in a better and more palatable condition for use on the table. These are sufficiently good reasons for every farmer to store a few tons of ice each winter.

The chief purpose of this bulletin is to describe how to harvest and store ice on the farm. In addition some plans of small ice cold storages are given for the benefit of farmers or others wishing to build large refrigerators for storing fruit or dairy products in larger quantities than the ordinary farmer would be handling. In no case, however, should perishable products be stored for long in any quantity in ice-cooled storages as the temperature cannot be maintained low enough to keep them satisfactorily.

A FEW USEFUL FACTS ABOUT ICE.

(1) Ice forms from water at a temperature of 0°C. or 32°F.

(2) A cubic foot of solid ice weighs 58 lbs. as compared with 62½ lbs. for water, therefore ice is 9-10 the weight of water.

(3) Ice occupies 1-10 more space than volume of water producing it. One ton of solid ice occupies 36 cubic feet, but as stored in ice-houses one ton requires about 45 cubic feet of space.

(4) Ten pounds of ice has about the same cooling effect as 100 lbs. of cold well water. Every pound of ice in melting abstracts 142 units of heat or enough to cool 10 lbs. water 14.2°F. See Table 1, page 39, for cooling power of ice.

(5) The cooling by ice is due to its melting and the faster it melts the greater becomes its value as a cooling medium. This is the reason for mixing salt with ice, as the salt has a great power to absorb water and thus hastens the rate of melting of the ice. Salt can be used profitably to the extent of one part salt to three parts of crushed ice.

(6) The sustaining power of a sheet of ice is considerable. Two inches thick will usually bear a man, five inches a team of horses and load weighing two tons.

(7) The best quality of ice is obtained from pure, clean and quiet water. The presence of snow or slush is very injurious to the quality and keeping power of ice.

(8) Ice has a specific heat of .5, or exactly half that of water, i.e., temperature of ice changes twice as fast as that of water.

Quantity of Ice Necessary to Store.

The quantity of ice required on the farm will depend on location, the number of cows milked, the methods of handling the product, the kind of ice-house, the size of the family and whether or not a household refrigerator is used.

To supply the needs of the average family there should be stored about 5 tons of ice, or about 50 cakes 22 inches square and 12 inches thick allowing for considerable waste.

For dairy purposes there should be provided 1½ tons per cow where whole milk is cooled, and ½ ton per cow where only the cream is cooled.

The Cost of Storing Ice.

This cost is very difficult to estimate and of course varies with localities and the distance the ice has to be hauled. It would probably be fairly close to the mark to estimate the cost at $1.50 per ton where the ice-house is close to the source of supply, otherwise it might run up to twice that amount.

THE MOST ESSENTIAL FEATURES OF THE DESIGN AND CONSTRUCTION OF THE FARM ICE-HOUSE.

The farm ice storage house need not be expensive or elaborate. If the following features be embodied in its construction and a good quality of ice be properly packed into it, the ice will keep well no matter what kind of a storage be used.

Chief Requirements.

(1) *Suitable Location.*—The preferable location is in the shade, but where there is a good circulation or movement of air. Stagnant air in summer time usually becomes very hot at times, and this condition would melt the ice rapidly. Reasonable protection from direct rays of sun usually gives best results.

(2) *Plenty of Insulation.*—The insulation is the material about the ice, including walls, roof and sawdust, or whatever packing is used around the ice. A foot or two in thickness is not too much and the material should be dry and clean and well tamped in between the walls and the ice. The most suitable material for walls and roof is lumber, and for packing the following materials may be used: Sawdust from well-dried lumber, marsh or wild hay, and shavings.

(3) *Circulation of Air Over the Ice.*—About the eaves, in the gables and at the ridge there should be plenty of openings to permit air to move freely through the top of the ice-house, and yet protected enough to keep out the rain.

(4) *Drainage.*—The waste should be able to get away readily through the soil below the storage. If soil is not well drained naturally, it is highly advisable to install a tile drain carried to a good outlet.

(5) *Keeping Air Away from Ice.*—This may be done by making the foundation tight by banking up with soil, or otherwise by always covering up the ice well whenever any is removed, and by packing the cakes closely together and filling all spaces with small pieces of ice or snow when filling the house.

(6) *Wall Construction.*—The double wall made by clap-boards on the outside and rough lumber on the inside of the studding is the best. It is some improvement to provide for circulation of air between the two walls from bottom to top by making holes at bottom and top of the wall. This arrangement will help to keep the walls dry and make them longer lived, and prevent stagnant hot air accumulating in the intervening space.

TYPES OF FARM ICE-HOUSES.

(See Figs. 1, 2, 3.)

Below are shown plans for two standard types of ice-houses for farm use, type "A" being a very simple construction, and type "B" a more modern and, naturally, more costly. The first will keep ice satisfactorily if plenty of packing material be used. The cheaper type may consist of a large bin constructed under an open shed, in the woodshed or in one side of an unused hay mow. Even an old abandoned silo may be utilized for this purpose if drainage can be secured conveniently. Again I would emphasize the importance of insulation, circulation of air over the ice, careful packing and drainage as explained in the preceding paragraph.

Type "A" Ice-House.

The drawings convey practically all the information required as to construction. This style might be slightly modified to suit different conditions, for instance, it might be built against another building as a lean-to.

This house will hold 20 tons of ice, or about 275 cakes, each 12 inches by 22 inches by 22 inches. The posts should be treated with a wood preservative before they are put into the ground.

The following bill of material may be found helpful to anyone contemplating the building of this house.

Bill of Material for the Erection of Type "A" Ice Storage House Built of Cedar Posts and Rough Lumber.

Cedar posts to be sunk in the ground to a depth of three feet below ground level and to be prepared with a water-proofing material to prevent rot.

The floor of ice-house to be composed of rough gravel and stone to insure good drainage.

A 4-inch tile drain to be laid below rough gravel bedding to a depth of three feet.

Cedar posts	16 lengths, 14 ft. posts.
Rough boarding, 1-inch	930 square feet.
Eave plates	2 lengths, 2 x 4 x 13 feet long.
Ridge bar	1 length, 1 x 4 x 13 feet long.
Door framing	2 lengths, 1 x 4 x 9 feet 6 inches long.
Door framing	2 lengths, 1 x 4 x 4 feet long.
1 Door	3 feet 0 inches x 6 feet 0 inches.
1 Door	3 feet 0 inches x 3 feet 0 inches.
Ready roofing material	208 square feet.
Sawdust for filling	18 cubic yards.
Hardware, such as nails, hinges, screws, etc...	

Type "B" Ice-House.

Type "B" stands for a better built and a more attractive ice-house. In many instances a small milk and dairy room or refrigerator chamber is built in conjunction with this type. The space between the two walls may be packed with planer shavings or may be left empty; if filled, less sawdust or material will be required next to the ice. If plenty of good sawdust can be secured, the wall may be cheapened considerably by using only two thicknesses of boards, clap-boards or drop siding on the outside and rougher lumber on the inside face of the studding. Attention is called to the provision for circulation through the top and drainage below the ice and also the air-tight foundation. This house will hold about 25 tons of ice, five tons more than type "A" of similar size because less sawdust is required.

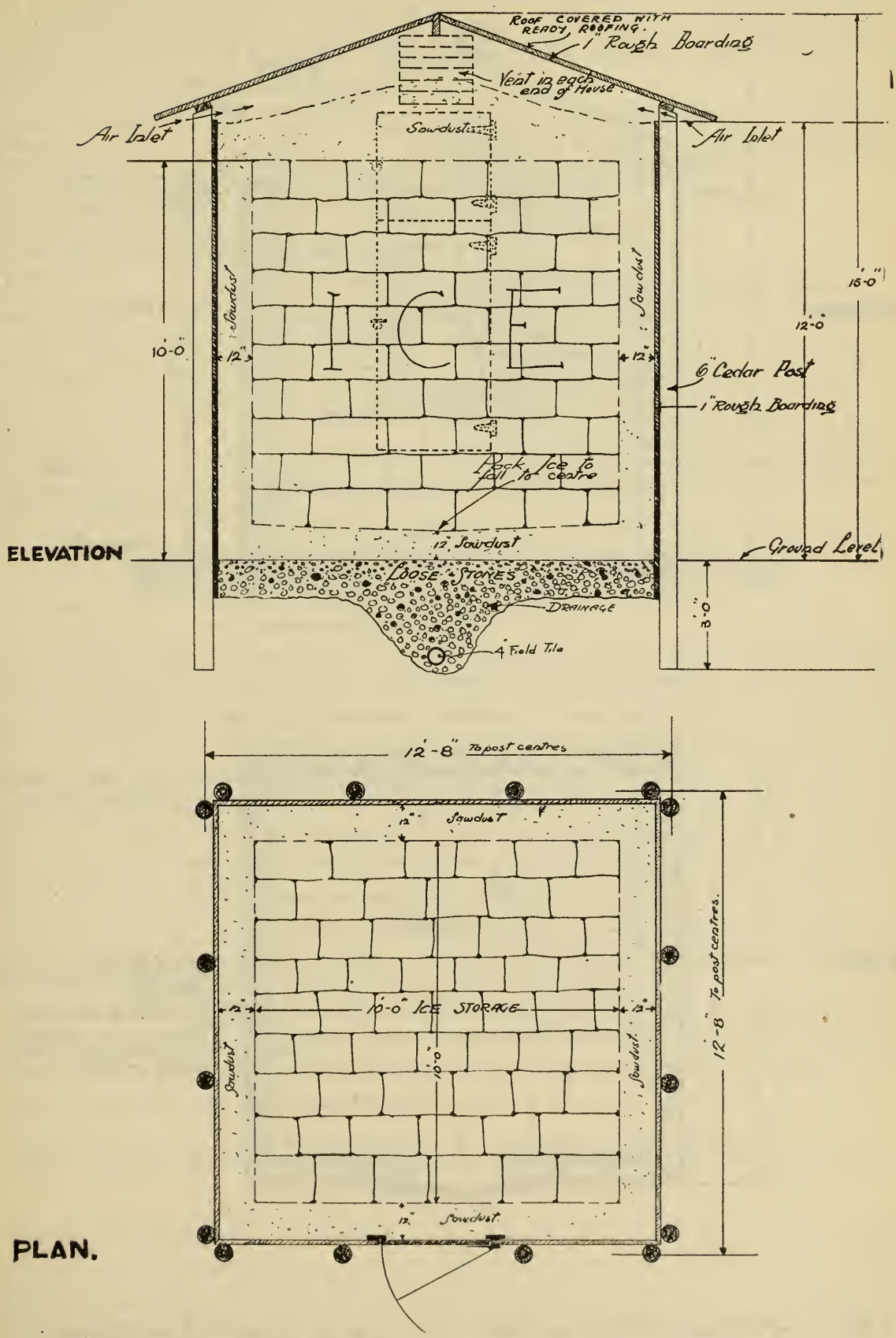


FIG. 1.—Ice Storage House. Built of cedar posts and rough lumber.

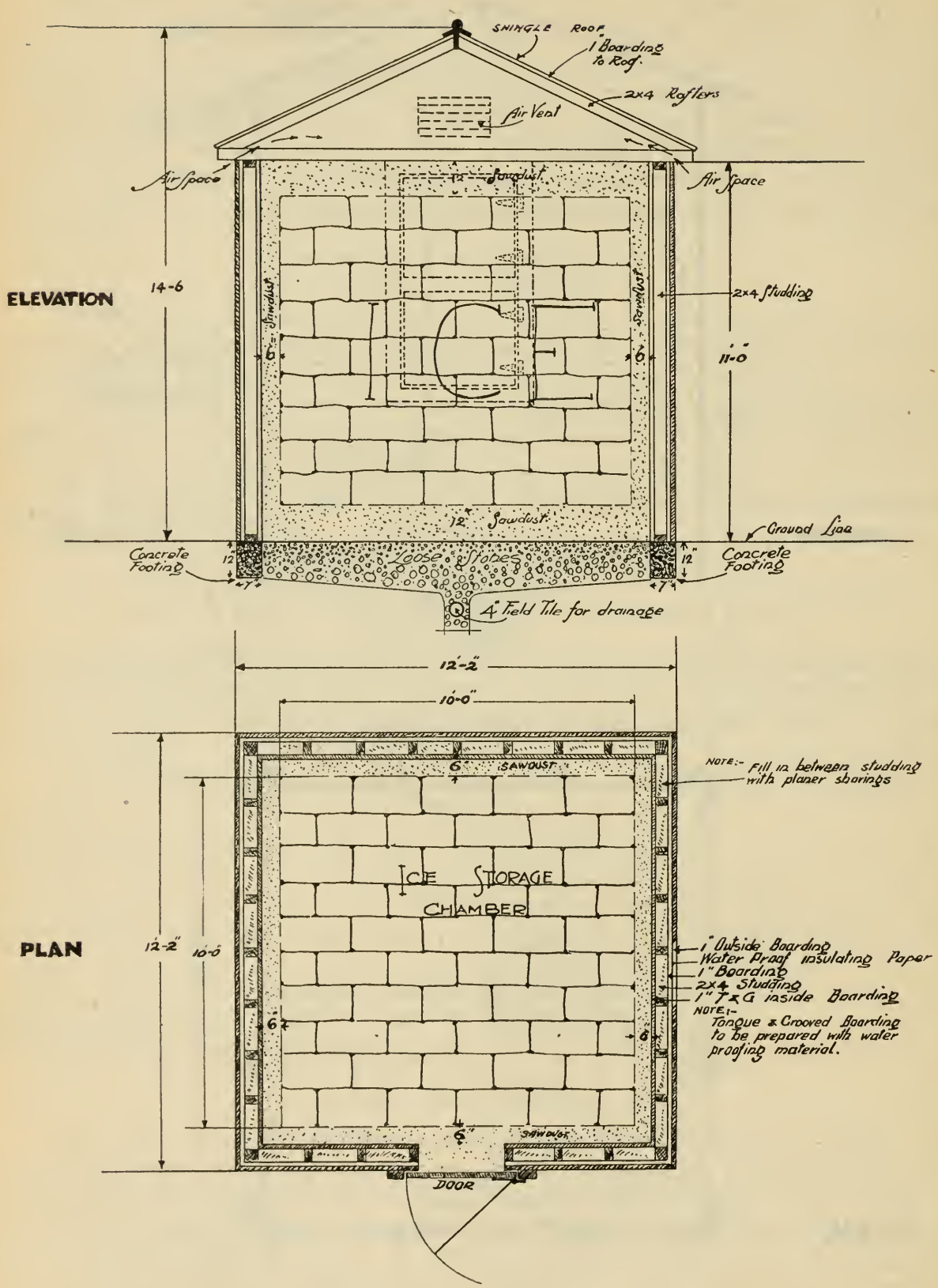


FIG. 2.—The Standard Type Ice House. Built of good material and well insulated.

Bill of Material for the Erection of A Standard Type of Ice-House.

This house to be built on a concrete base 12 inches deep by 7 inches thick. Over all size to be 12 feet 2 inches by 12 feet 2 inches outside measurements, comprising 30 cubic feet of cement. Floor of ice-chamber to be of loose stone brought to a level with the top of cement base, a 4-inch tile drain to run through the centre for drainage purposes.

Sills and wall plates	8 pieces, 2 x 4 inches x 11 feet 10 inches long.
Studding	28 pieces, 2 x 4 inches x 10 feet 8 inches long.
Corner posts	4 pieces, 4 x 4 inches x 10 feet 8 inches long.
Outside matched boarding, 1-inch	536 square feet.
Rough boarding, 1-inch	536 square feet.
Waterproof insulating paper	536 square feet.
G. and G. boarding, prepared with water-proofing material	524 square feet.
Rafters	18 pieces, 2 x 4 inches x 7 feet 6 inches.
Rafters	9 pieces, 2 x 4 inches x 13 feet 2 inches.
Rough boarding, 1-inch	195 square feet.
Shingles	195 square feet.
Ridge boards	3 pieces, 1 x 4 inches x 1.3 feet o inches.
Ridge roll	1 piece, 13 feet long.
2 doors	3 feet 0 inches x 3 feet 0 inches.
Door framing	2 pieces, 1½ x 3 inches x 14 feet 0 inches.
Door framing	3 pieces, 1½ x 3 inches x 3 feet 2 inches.

Planing shavings for packing between studding. Sawdust for filling. Hardware, such as nails, hinges, screws, bolts, etc.

Ice-House with Ice Enclosed Cooling Room.

(Type C, Fig. 3.)

In type C, Fig. 3, the chief feature is a small cooling room almost entirely enclosed or surrounded by ice. The room is built of concrete and as the drawings show, inlets for fresh cold air are provided for by inserting a few tile in the bottom of wall, also an outlet for foul air just above the door. The floor is concrete and slopes slightly to a drain with a trap. The size should be about 5 or 6 feet square and 6½ feet high. A suitable location for this building is against one side of the dairy stable wall with a small dairy room adjoining, so that it will be convenient for storing milk and cream. Other perishable products also may be stored in this chamber in small quantities for a few days.

In this design there is no handling of ice as is the case in many small refrigerators, and the cooling room is well protected from the sun and warm air. The ventilation keeps the air inside in good condition.

As the plans are drawn in detail, there is no necessity for giving any further description of the construction. The Department of Physics will be pleased to send a large blue-print of these drawings to anyone thinking of constructing this type of ice-house and refrigerator.

Bill of Material for Ice Storage and Cooling Plant Specially Recommended for Dairy Farms.

This ice storage plant is built as an attachment to dairy room or stable. Doors to cooling chamber to enter from same as per illustration. Cooling chamber to be built entirely of cement with inlet for cold air at the back and near the floor, all as described on illustration. Outlet for foul air is built in roof above the entrance door. Ice storage chamber to be built with a floor of rough stone and loose coarse gravel, this being for the purpose of good drainage. A 4-inch tile drain to be bedded in gravel floor. Wall plates to be built up from cedar posts sunk in ground.

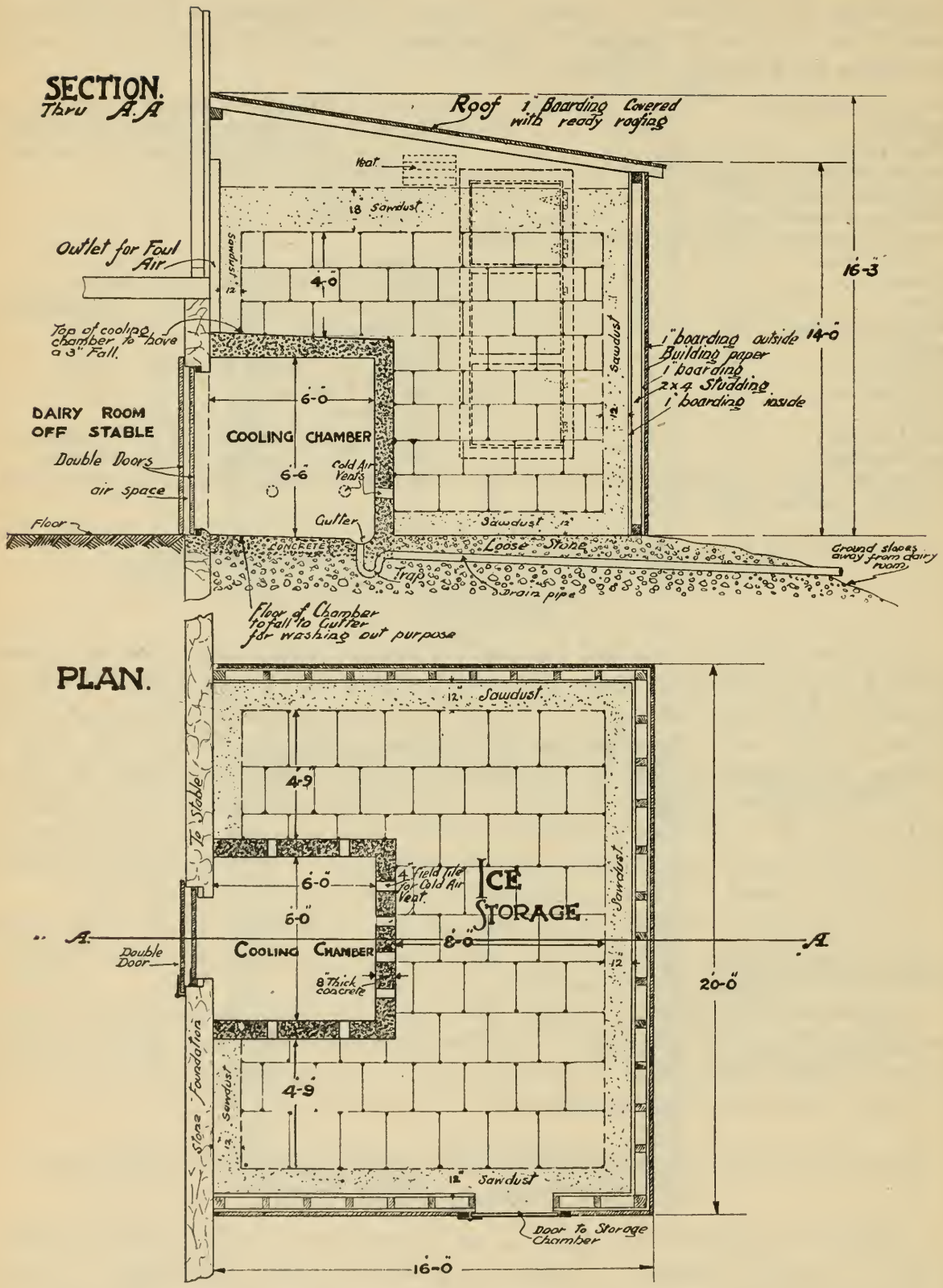


FIG. 3.—Ice Storage and Cooling Plant. Specially recommended for dairy farms.

Cement work, 8 inches thick	5½ cubic yards.
Dressed lumber for outside, 1-inch	880 square feet.
Building paper	880 square feet.
Rough boarding, 1-inch	1860 square feet.
Sills and plates	4 pieces, 2 x 4 inches x 16 feet 0 inches long.
Sills and plates	2 pieces, 2 x 4 inches x 20 feet 0 inches long.
Studs	11 pieces, 2 x 4 inches x 13 feet 8 inches long.
Studs	16 pieces, 2 x 4 inches x 16 feet 0 inches long.
Corner posts	2 pieces, 4 x 4 inches x 14 feet 0 inches long.
Corner posts	2 pieces, 4 x 4 inches x 16 feet 0 inches long.
Rafters	13 pieces, 2 x 4 inches x 17 feet 0 inches long.
2 doors	3 feet 0 inches x 3 feet 0 inches.
Door framing	35 linear feet 1 x 3.
Sawdust for filling.	
Cedar posts	8 pieces 8-inch post, 3 feet 0 inches long.
Hardware—nails, screws, bolts, hinges, etc.	

Combination of Ice-House, Dairy Room and Ice Enclosed Cooling Room.

(Type D, Fig. 4.)

On the large dairy farm there is need for a building of this type. With the use of a track and carrier, as shown in the plan, the labour of handling the milk and cream is eliminated to the greatest possible extent. Cakes of ice may be taken from the ice-house, if necessary, for use in the dairy room as elsewhere. If plenty of good quality, dry sawdust can be easily secured the construction of the wall of the ice-house may be simplified and considerably cheapened by using only clap-boards on the outside and rough lumber on the inside of the studding, and using a foot or more of sawdust between the wall and the ice.

The plans are drawn with sufficient detail to enable anyone familiar with estimating material to figure out the amount of lumber and concrete required to construct the building.

THE CARE OF MILK AND CREAM ON THE FARM.

The two diagrams shown below (Fig. 5) offer valuable suggestions for equipping a milk-room such as has just been described, with cooling tank for either cold water or ice, and a hoist for handling the cans. These appear in two circulars issued by the Dairy Branch of the Department of Agriculture, Toronto, together with the following extract:

"The accompanying illustration (Fig. 5) shows a tank for cooling milk and a crane or hoist for raising the cans from the tank. With such an outfit milk cans may be lowered and raised from the cooling tank with ease, and sweet, cool milk for delivery at the factory is assured during the warmest weather."

A Small Cold Storage with Ice Chamber Above the Cooling Room.

(Type "E," Fig. 6.)

A very common design of a small ice-cold storage plant is that of the ice-over-head-system. It is limited to plants of small size such as are suitable for farms, butchers' stalls, country stores, florists, etc. It is not practicable to build this style on large dimensions as the weight of ice is too great a strain on the floor of the ice chamber and causes leaks into the cooling room. As provision for circulation between the ice chamber and the cooling room can be

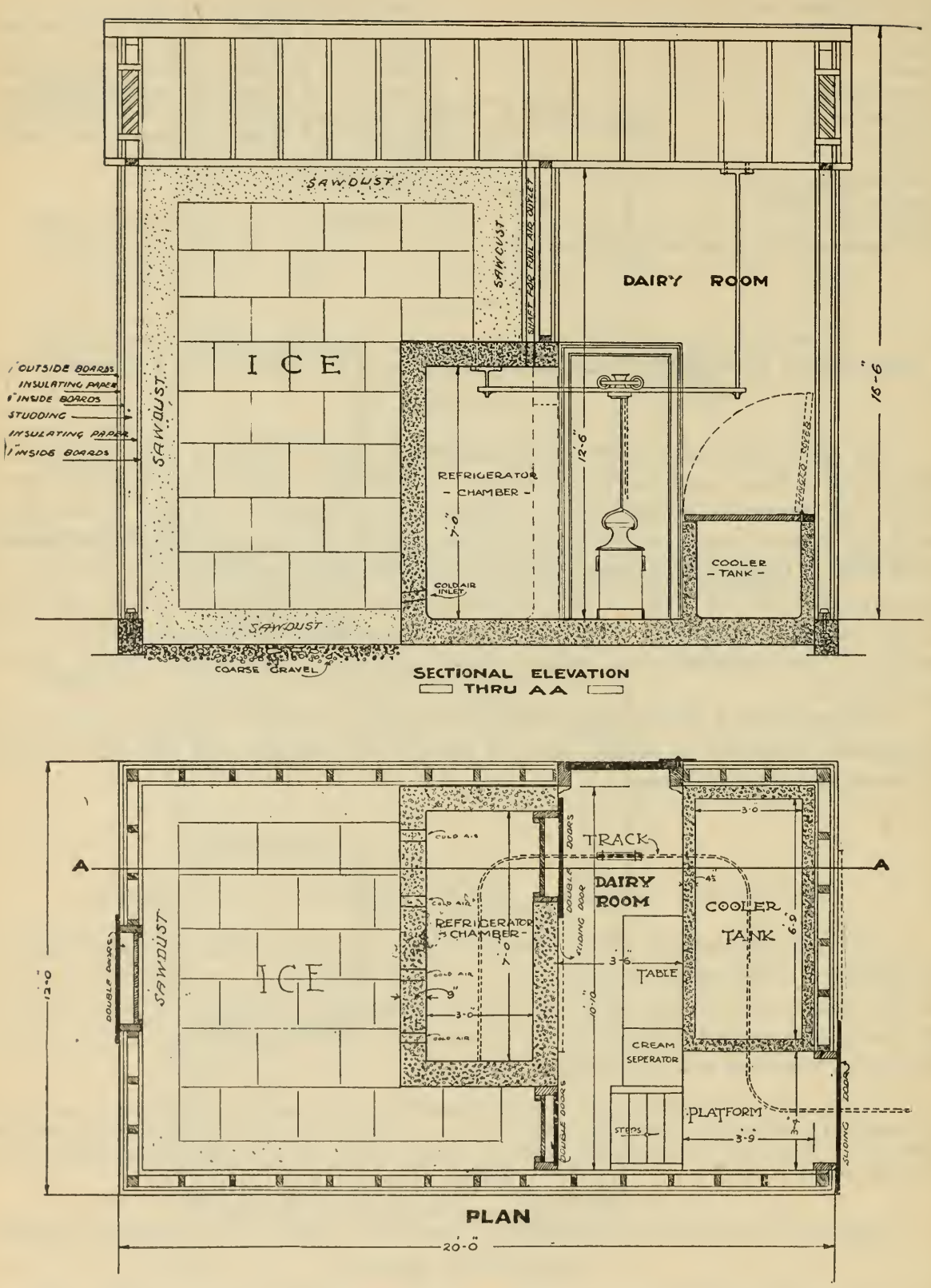
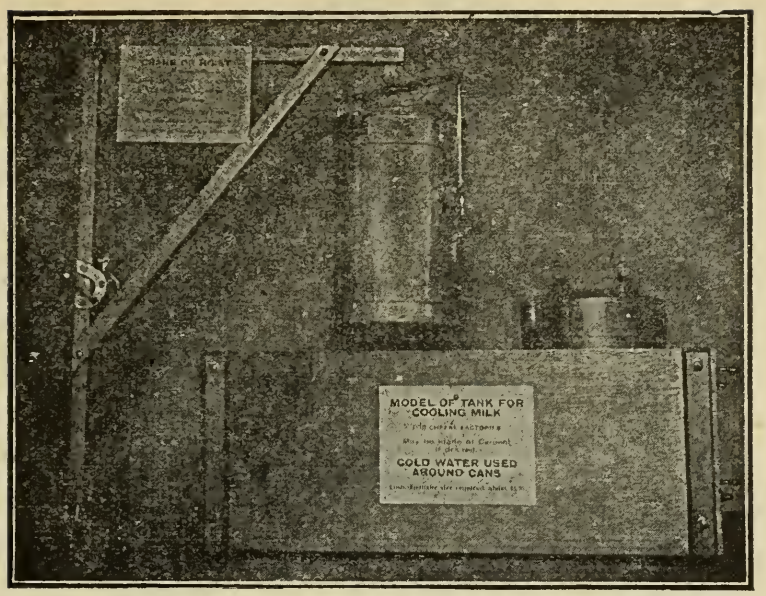


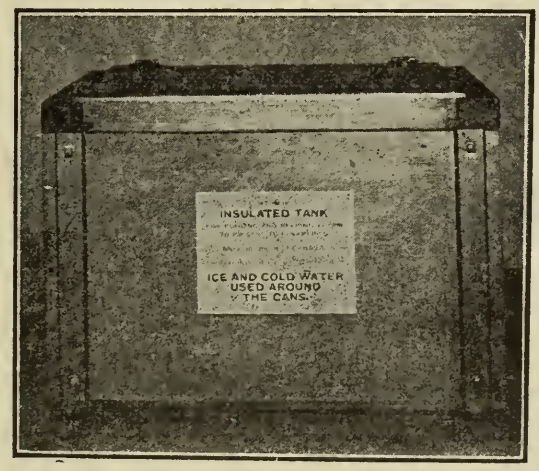
FIG. 4.—Farm Dairy Plant. Equipped with dairy room, cooling tank, refrigerator, and track with carrier for handling milk and cream cans.

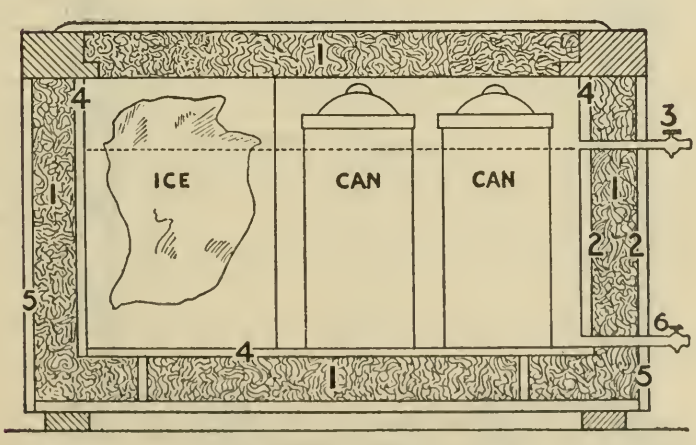
Tank for Cooling Milk and Hoisting Apparatus.



"One of the most important factors in the production of cream is that as soon as it comes from the separator it be quickly and thoroughly cooled to a temperature of 50 degrees, and kept cool until it reaches the creamery. Do not mix cold and warm cream.

Tank for Cooling and Keeping Cream.





1—Mill Shavings. 2—Two-ply damp-proof paper. 3—Overflow water-line. 4—Inner tank made of 1-inch lumber. 5—Outer shell of 1-inch lumber. 6—Bottom outlet.

Fig. 5.

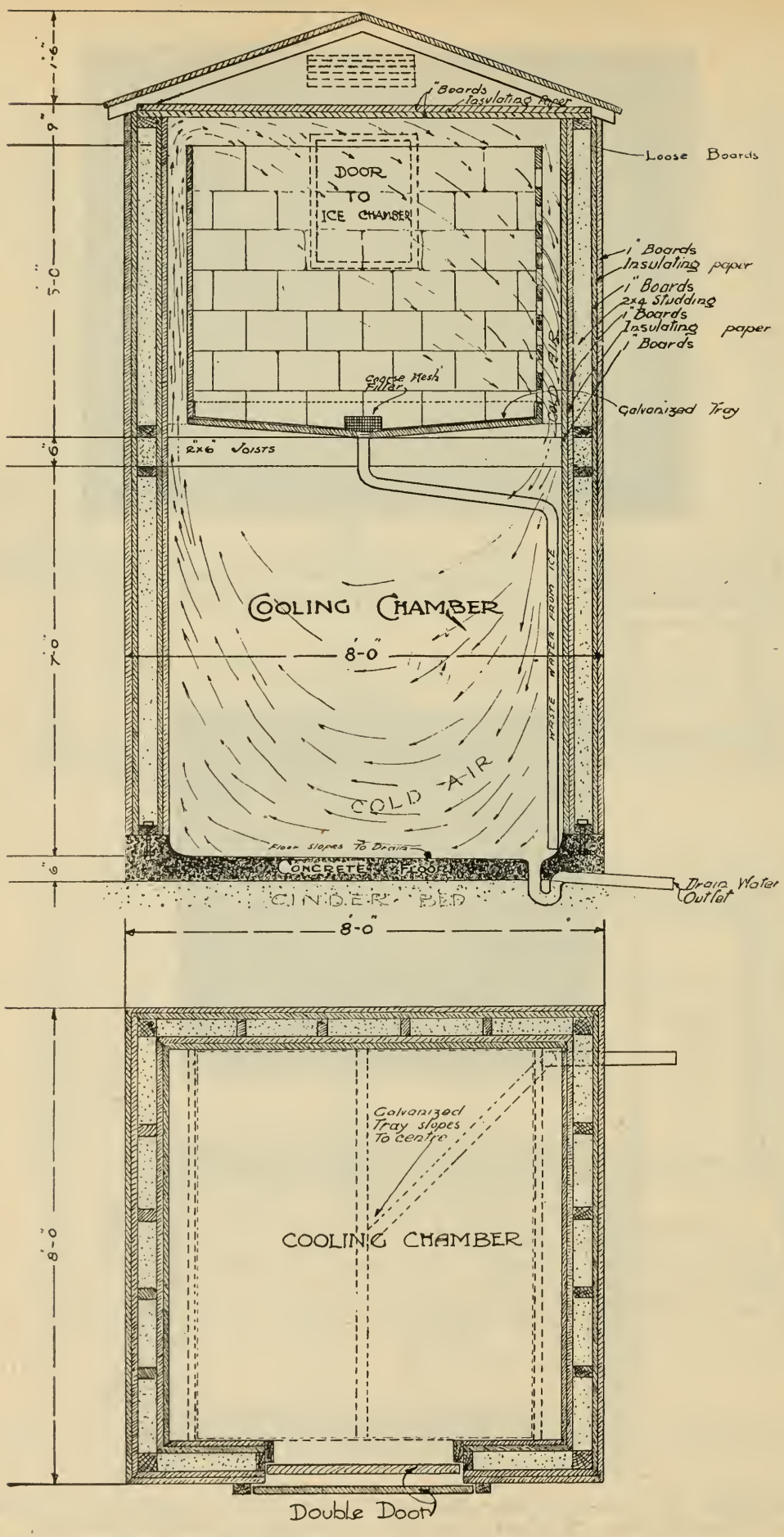


FIG. 6.—Small Cold Storage, with ice above the cooling chamber.

provided for, very good results can be secured with this system. The greatest objection to it is the fact that the ice chamber has to be filled frequently by the ice dealer or from a supply in an ice-house on the premises. This style may be purchased from refrigerator dealers all ready to install inside another building. The design shown in Fig. 6 is the simplest plan for a home-made one and it should give very good results. The circulation of air between the upper and lower chambers is made possible by having air passages, as indicated, on two opposite sides of the room, one for descent of cold air from the ice chamber, and the other for escape of used air from the storage to the ice chamber above. The wall enclosing the ice must be built as the plan shows with open spaces on the one side adjoining the cold air duct, in order that the cold air from the ice may have free escape into the cooling room below.

Small Cold Storage with Ice-Box in the Cooling Room.

The simplest and cheapest method for cooling a small room is to place blocks of ice upon a rack in the room and placing a drip pan beneath to catch and dispose of the waste water. Better results are secured if the rack be placed along one side of the room and a solid partition constructed between the ice and the cooling storage space with openings at both the top and bottom of the partition for circulation of air between the two chambers. The ice is usually put into the ice-box or bunker through a trap door at the top of the bunker. The plans, Figs. 7 and 8, given herewith, and the following description are taken from a report by Mr. J. A. Ruddick, Dairy and Cold Storage Commissioner for Canada.

"All lumber, except clap-boards, should be tongued and grooved, and spruce only should be used for the ice-box, cold-room and ante-room. No tar paper should be used, on account of its strong odour.

"The building will be better and more permanent if placed on a stone or concrete wall. Otherwise it must be well "banked" to prevent circulation of air underneath.

"The extra course of lumber under the siding may be dispensed with on the walls of the ice chamber, but not on the other parts of the building.

"The partitions between the ice chamber and the other compartments, and also between the ice-box and the cooling room, need to be well insulated, as shown, to prevent dampness. A poorly insulated partition against an ice chamber will become cold on the surface and consequently collect moisture. Many refrigerators and cold storages are failures from this cause. Emphasis is laid on this point, because we often find thin partitions placed between the ice chambers and the cool roons, on the theory that refrigeration secured in this direct way is all that is needed. Dryness in a refrigerator is just as important as a low temperature.

"No roof is shown in the plan. That is left to the fancy of the builder,

"Sufficient room must be left above the small compartments to allow of the blocks of ice being transferred to the ice-box through the ice trap door.

"The window in the ante-room has double sash, each sash being double glazed, giving four thicknesses of glass.

"The floor under the ice-box should be covered with galvanized iron, sloping in one direction, with a gutter at the lowest edge to carry off the water from the melting ice. The drain pipe from the gutter must be trapped to prevent the passage of air. A simple plan is to have the end of the pipe turned down and extending nearly to the bottom of a small dish or vessel of any kind, so that the water will rise above the end of the pipe before the dish overflows.

"Planing mill shavings are highly recommended for filling the spaces between studding and joists as shown on plans. They are always dry and do not become musty. If they cannot be procured, sawdust is probably the next best thing, but it should be *thoroughly* dried before being used.

"The spaces between the studding around the ice chamber should not be filled. Any filling will eventually become damp from the ice, and damp material of any kind has very little insulating value.

"*Management.*—As there is no floor in the ice chamber, the earth beneath it should be well drained. Cover the surface with 6 to 8 inches of broken brick, coal cinders, tan bark or other similar material of a non-conducting character. If nothing better can be procured use broken or cobble stone, covered with a layer of gravel or sand. This material will make the permanent bed.

"Before filling with ice, put 8 inches of sawdust over the permanent bed. This should be renewed every year. The ice should be packed as closely as possible, filling all spaces with crushed ice or snow, well rammed. Leave a space of 12 inches between the walls and the ice, to be filled

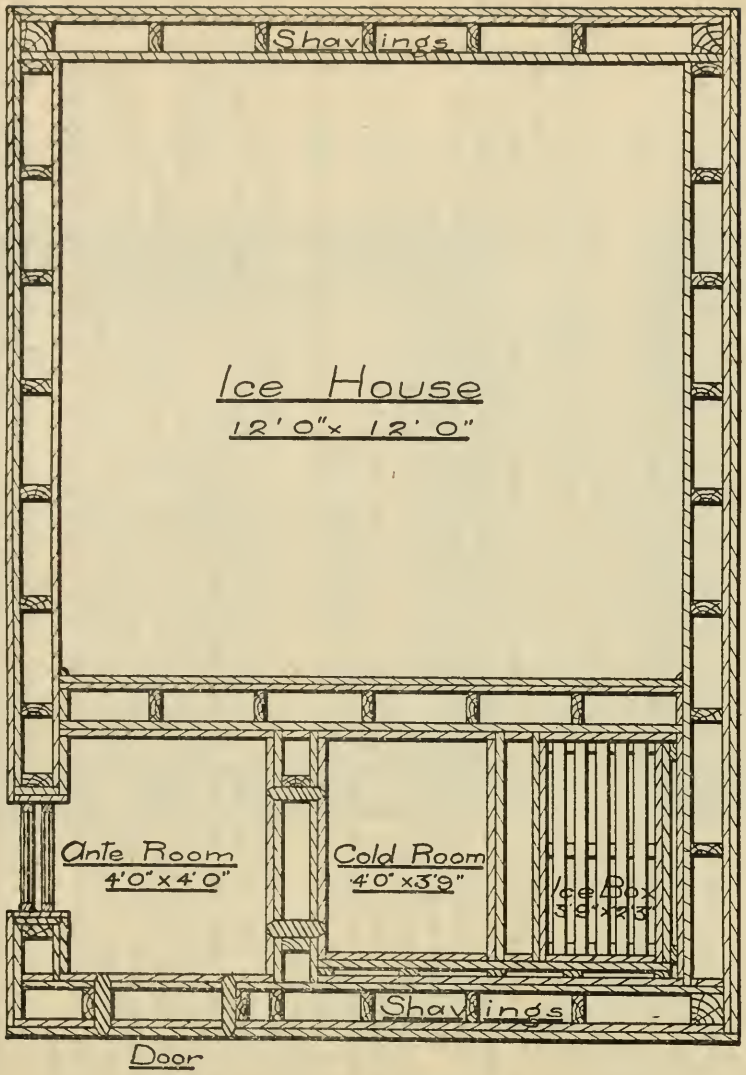


FIG. 7.—Plan of Small Cold Storage (after Ruddick).

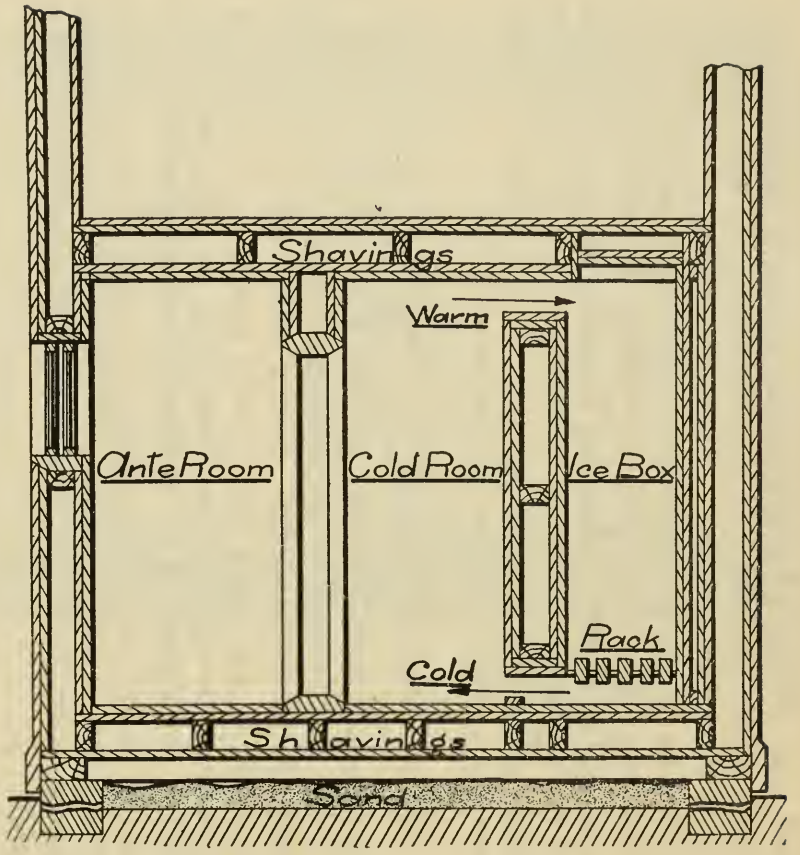


FIG. 8.—Section of Small Cold Storage (after Ruddick).

with dry sawdust. The top of the ice should also be covered with 12 inches of dry sawdust. If sawdust cannot be procured, cut hay or straw may be used, but the space filled should be 18 inches instead of 12, and the filling well packed.

"To utilize the cold room, fill the ice-box with cleaned ice in lumps as large as convenient to handle. The box shown on the plans will hold about a ton of ice, so that it will not need to be filled often, Care should be observed in keeping the trap door tightly closed. The openings at the top and bottom of the partition between the ice-box and the cold room may be fitted with a slide to regulate the circulation of air.

"Particular attention must be paid to the keeping of the doors perfectly air-tight. A cushion of thick felt for the door to close against is about the best thing to ensure a good joint."

Special Notice.

Any dairy farmer or creamery man who is contemplating the erection of a small ice-cold storage plant should secure a copy of Bulletin 16, "Small Cold Storages and Dairy Buildings," by J. A. Ruddick and Jos. Burgess, before deciding on his plan as it contains several types different from the ones described above. Write Dairy and Cold Storage Branch, Department of Agriculture, Ottawa.

REFRIGERATION IN THE HOME.

One great advantage of storing ice is to have some for use in keeping the foodstuffs for the table in a good and palatable condition during the hot weather. There are times during the summer that it is impossible almost to keep milk and cream sweet, to preserve the butter in good condition, and to keep other perishable foods fit for use without ice. Nor can cold drinks be made without it. In sickness, too, it may be very necessary.

Types of Refrigerators.

1. *The Ice Box.*—If one does not wish to go to the expense of buying a real refrigerator, he may make a simple ice-box after the fashion of that illustrated in Fig. 9.

Its form is like a large chest. The dimensions will depend upon the size of the family or the amount of goods required to be stored at any one time, but a box about four feet long, two feet deep and two feet wide would be somewhere near the right size for the average family. It should be constructed of good quality, well dried tongued and grooved lumber and preferably spruce for the interior sheathing, as it is free from odour. The space between the two sheathings, not less than two inches, should be filled with dry shavings, or ground cork, or wool or any poor conductor of heat, which is suitable to pack into the space between walls. See notes on insulating materials, page 30. The interior surface should be coated with some odourless water-proofing material to preserve the wood. A suitable thing for this would be a couple of coats of good shellac.

The exterior surface should be painted with some desirable colour. There should be a drip pan placed beneath the ice and a drain pipe connected therewith. The ice should rest upon a rack bottom which should be removable for cleaning purposes. It is quite essential to have a rack bottom in the food chamber, also in order to improve the circulation of air as shown by arrows in the plan. The partition should be open at bottom and top to allow the air to circulate between the two chambers. There is no reason why this cooling box cannot be made at home as the construction is very simple. We do not claim

that it will give as good satisfaction as a modern refrigerator, but nevertheless it would be very useful, and the cost would be within the reach of nearly every family.

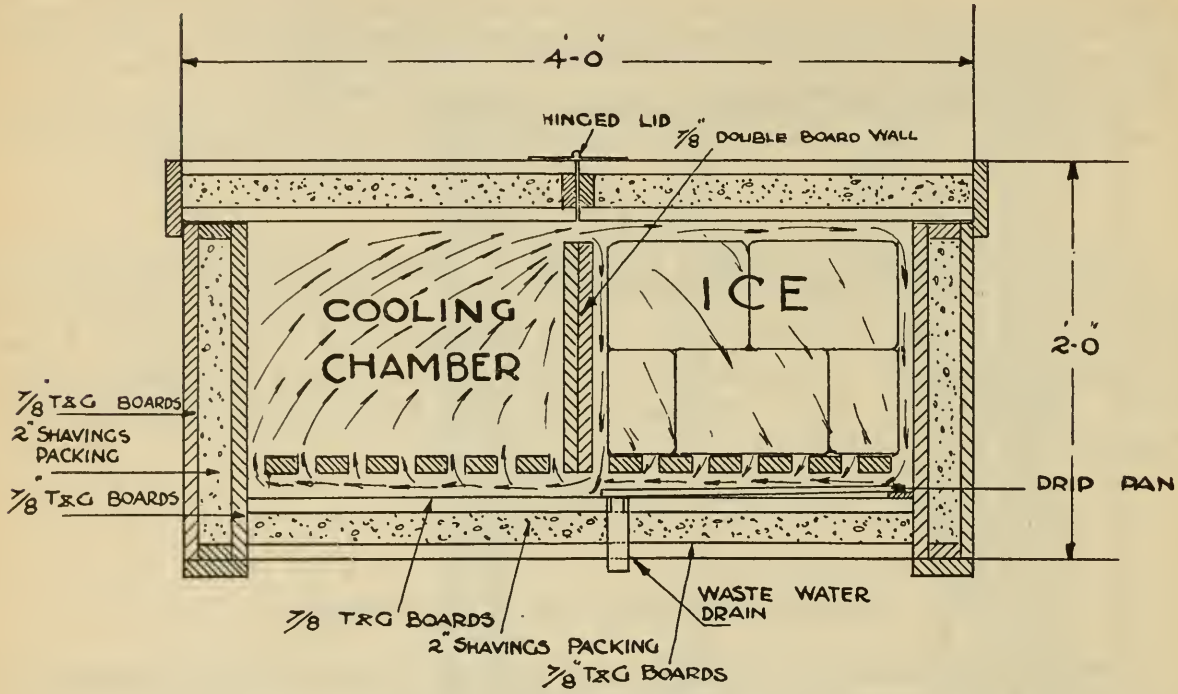


FIG. 9.—Ice Box.

2. *The Modern Ice Refrigerator for Household Use* (See Figs. 10 and 11).—In recent years there has been a great improvement in household refrigerators—in construction, finish and appearance and efficiency. There are many different styles or makes on the market and the prices range from about $12 to $40 for the ordinary sizes in most common use.

Size.—The sizes suitable for homes vary somewhat. A general idea of the range of sizes may be had from the following list:—

SMALL SIZE

	Height	Width	Depth
Outside measurements	45 in.	27½ in.	17¾ in.
Ice chamber	9¾ in.	18 in.	11 5/8 in.
Provision chamber	18¼ in.	20½ in.	12 1/8 in.
Shipping weight	150 lbs.		
Ice capacity, about	70 lbs.		

MEDIUM SIZE

	Height	Width	Depth
Outside measurements	49 in.	29½ in.	21¾ in.
Ice chamber	10 in.	22 in.	16 in.
Provision chamber	22 in.	24½ in.	16 in.
Shipping weight	200 lbs.		
Ice capacity	115 lbs.		

LARGE SIZE

	Height	Width	Depth
Outside measurements	57 in.	44 in.	27 in.
Ice chamber	27 in.	14 in.	18 in.
Provision chamber No. 1	12 in.	17 in.	22 in.
Provision chamber No. 2	19 in.	17 in.	22 in.
Shipping weight	560 lbs.		
Ice capacity	220 lbs.		

These three sizes, or thereabouts, will meet the requirements of almost any home in city or country. The small size is large enough for very small families. Many of the large refrigerators have two or three separate cooling

chambers and this is a very desirable feature when considerable quantities of different foods are stored for several days, because certain products as eggs and butter will absorb odour from fruit and vegetables if stored in the same chamber for even a few days.

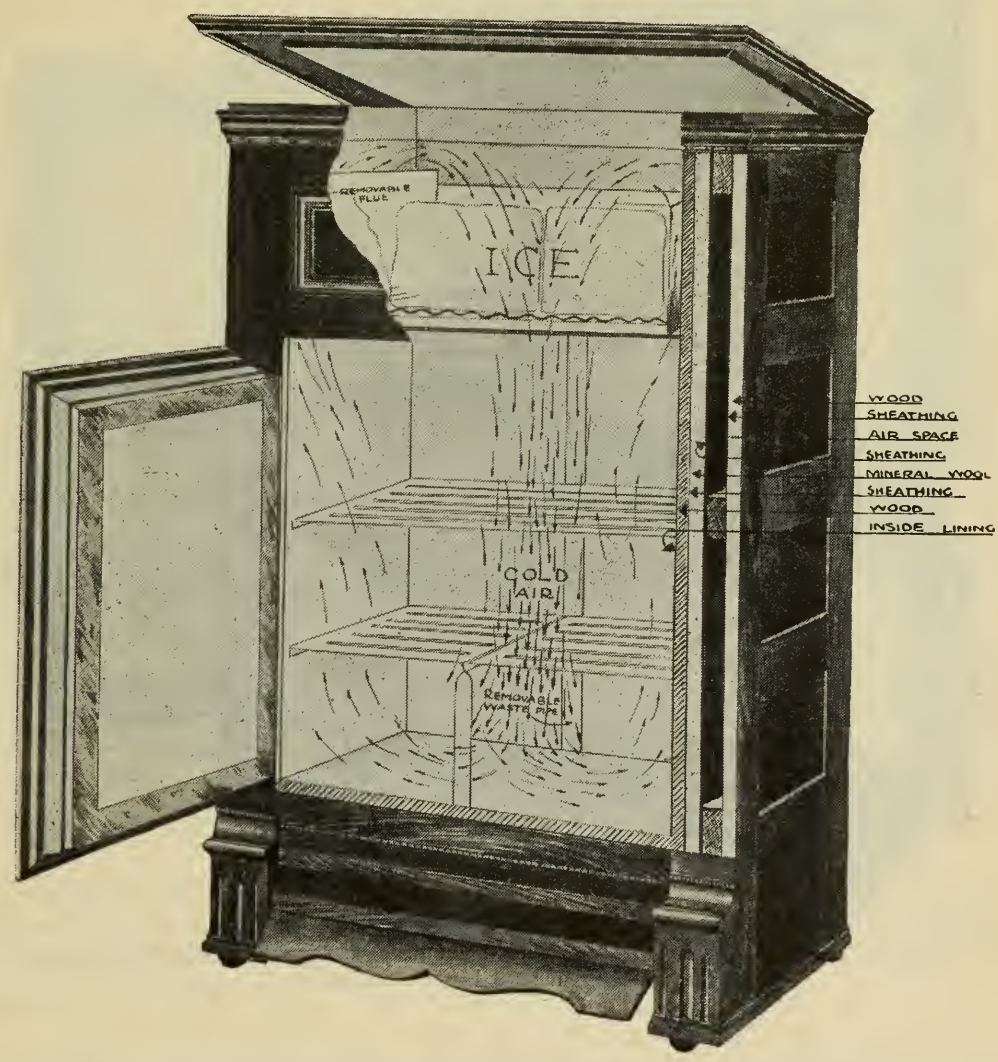


FIG. 10.—Household Refrigerator, showing construction and circulation when the ice chamber is above the refrigerator.

Quantity of Ice Required per Week.—The amount of ice that any refrigerator will use per week or month will vary with the temperature of the room where the refrigerator is kept, the amount of goods stored, the insulation of the walls of the refrigerator and the quantity of ice in the ice-box. It is noted that the ice capacity of the small size is 70 lbs., the medium 115 lbs., and the large 220 lbs. These quantities are, in the writer's opinion, rather too high unless the ice is packed in pretty well. In practice the amounts put in at one time are about 50, 90 and 175 lbs., respectively.

It is advisable to keep the ice chamber as well filled as possible, because the ice will last longer and a lower and more uniform temperature will be maintained in the food chamber below. A large household refrigerator about the size mentioned above and well insulated, requires about 30 lbs. of ice per day, or from 200 to 225 lbs. per week, for average conditions of summer weather. The small or medium size not so well insulated will use about the same amount. Assuming that the refrigerator would be used for five months of the year it would

be necessary to provide for three or four tons or loads of ice for household use; this amount would supply plenty for the household purposes and allow for considerable waste.

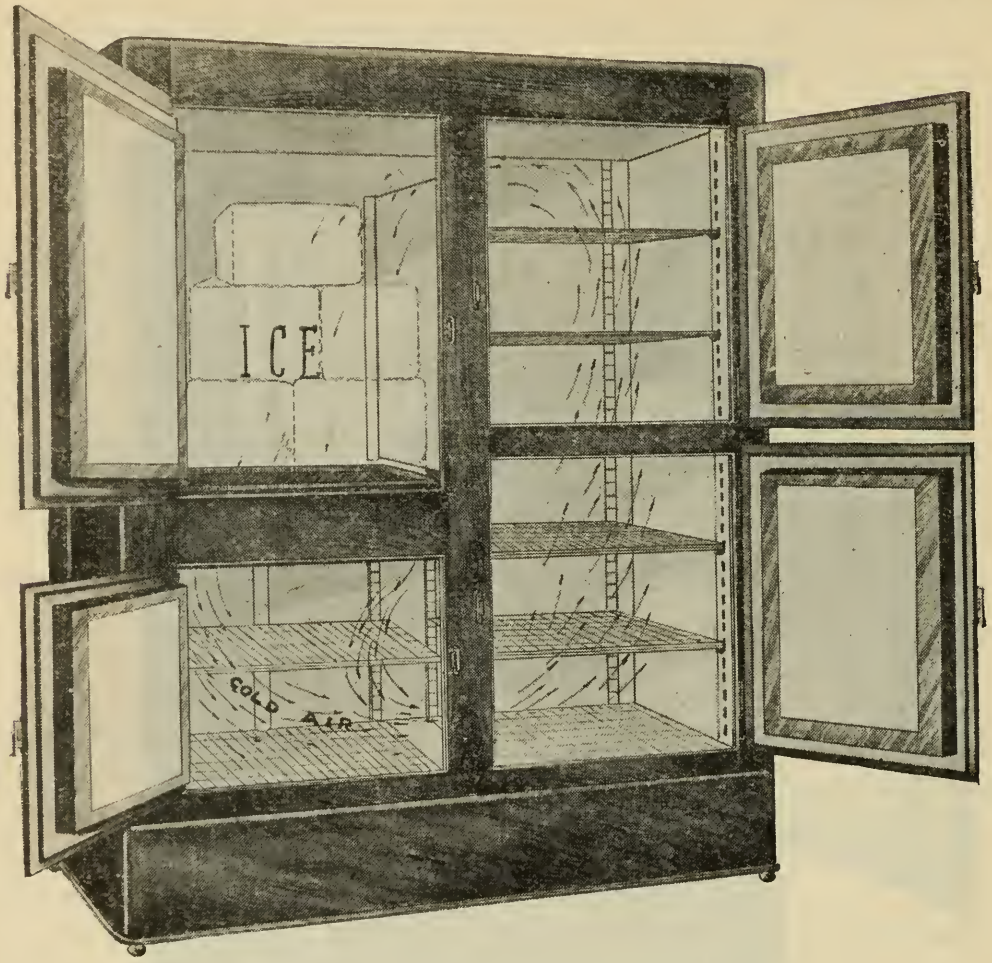


Fig. 11.—Household Refrigerator, showing construction and circulation when the ice chamber is at the side of the main refrigerator.

Suggestions on the Use of Refrigerators.

Every refrigerator is furnished with a set of directions and these should be followed closely if one wishes to get the best results from its use. The following are a few of the most important points to watch:—

(1) Keep the refrigerator on a level floor in a cool, dry place, and where it can be filled easily and without mussing the kitchen floor.

(2) Fill the ice-box regularly and use plenty of ice. Wash ice well before putting it into the ice-box.

(3) Clean the ice-box and the food chamber thoroughly once a week. The shelves, racks, and flues are all easily taken out, hence the cleaning can be well done in a few minutes. A damp cloth moistened with soda water or with water in which two tablespoonfuls of sweet nitre to the pint has been added is strongly recommended for cleaning the walls of the interior. It is advisable to place a saucer of charcoal in the food chamber to absorb odours and moisture. It will need to be renewed occasionally.

(4) Keep the doors or lids closed as much as possible, and when an article

is put into the refrigerator or removed, the door or lid should be closed as quickly as possible afterwards.

(5) Do not cover the shelves with paper or cloth and thereby obstruct circulation which is so necessary in the keeping of perishable products in cool chambers.

(6) Avoid putting hot, steaming or over-ripe, tainted or partially spoiled food or fruits in the refrigerator. If such a practice is followed the food chamber will be damp, foul and altogether unfit for keeping food of any kind in good condition.

(7) Keep the drain always clear.

3. *A Combination of Ice Refrigerator and Dumb Waiter.*—In the accompanying plan (Fig. 12) is shown how these two very necessary features of the farm kitchen may be combined to good advantage. The refrigerator is built in the basement and under the kitchen or pantry, and the dumb waiter is so arranged that the cage is lowered right into the cooling chamber alongside of the ice-box. Both the cooling chamber and the ice bunker is fitted with a door opening into the cellar, so that these chambers are made accessible for cleaning, filling the ice-box, if desired, and loading and unloading the dumb waiter.

The dimensions would be about as follows:—The cooling chamber 2 feet square, the cage of the dumb waiter 18 inches square, and the ice bunker 2 feet by 2 feet by 4 feet. This bunker would hold about one-third ton of ice or five or six very large cakes at once. With this capacity it would not be necessary to fill the ice-box very often and in addition there would be less meltage owing to the large quantity of ice in the box.

A cheaper construction than shown in the plan might be used, but the meltage would be greater and the temperature in the cooling chamber could not be kept so low or uniform. The size might also be somewhat reduced if the family were small.

4. *Cooling by Well or Spring Water.*—If one has plenty of cold water it is possible to get along without ice fairly well. A common practice is to set cans of milk and cream in tanks of cold, running water. Other articles could be kept cool in the same way. A food chamber could be kept quite cool by covering the interior walls with pipes and keep the cold water running through them all the time, provided the water was very plentiful and was kept under pressure enough to force it through the pipes.

5. *Cooling by Evaporation of Water from a Moist Surface.*—A considerable amount of heat is abstracted by the evaporation of water. This principle may be made use of by building a wooden stand with two or three tiers of shelves and covering the whole outside with cheese cloth or muslin and keeping it moist by having it in contact with a pan of water setting on top of the stand. There should be another tray at the bottom to catch the drip, if any. The evaporation of water from the moist surface surrounding the shelves will abstract enough heat from the immediate surroundings to keep a few articles of food, as butter, milk, cream, fruit, etc., placed upon the shelves, in a fair condition for a day or so. If the air can be kept moving rapidly over the moistened surfaces, the effect will be much better owing to more rapid evaporation.

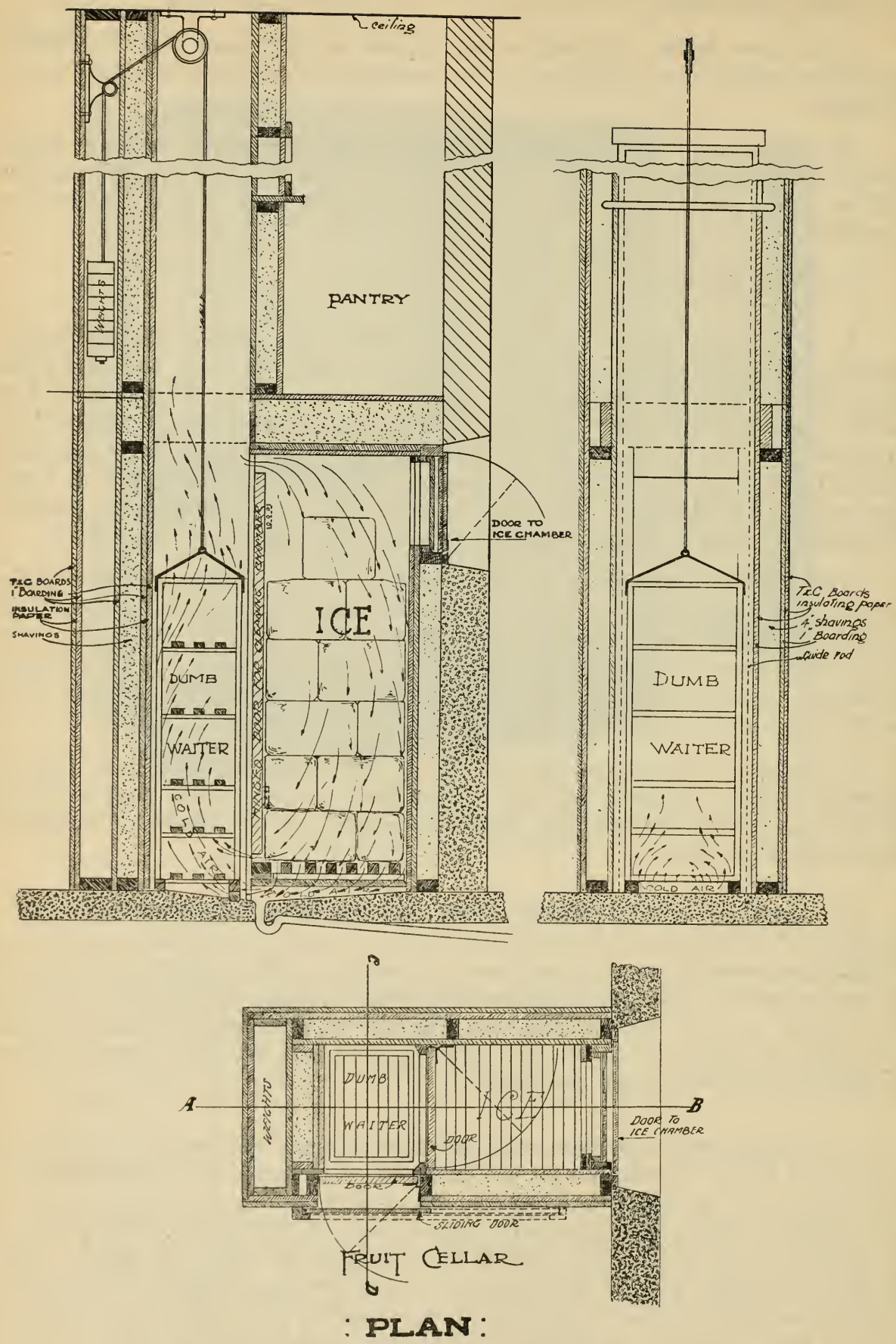


FIG. 12.—Household Refrigerator and Dumb Waiter Combination.

THE CARE AND MANAGEMENT OF AN ICE-COLD STORAGE.

(1) First of all, it is not possible to hold a cold storage room cooled by ice alone at a temperature below 40°F. The walls must be well insulated and the bunkers kept well filled to maintain this temperature during our hot season.

(2) Perishable materials like fresh meats will not keep in good condition very long in ice-cooled rooms, as the temperature is not low enough. It should be stored in very small quantities and for only a few days at the most. Do not leave any goods in the storage too long.

(3) To get the best results from storing perishable food products, they must be in first-class condition when put into the storage, i.e., free from incipient deterioration, diseases, bruises and not too ripe or matured. One bad piece will spoil the whole lot.

(4) It is advisable to store different classes of goods in separate compartments to avoid one tainting another. This is not possible always, especially in small storages that would be used on the farm. Particularly eggs and butter should not be stored with anything else that has a bad odour, e.g., *fish* or onions.

(5) Articles of food stored should be packed in such a manner that the greatest possible circulation of air can take place about them. Good circulation will maintain a more uniform and lower temperature and prevent air from becoming impure and too moist.

(6) In removal of goods from storage in the hot weather it is advisable to bring them into outside conditions gradually to prevent sweating and rapid deterioration.

(7) The interior of the storage must be kept scrupulously clean and sweet smelling. This may be accomplished by scrubbing out the storage once a year just before goods are put in, letting in the fresh air and sunlight to dry it out thoroughly, and then coat whole interior with whitewash with a little salt in it to make it stick well; or a weak solution of bi-chloride of mercury (poison), one part in 1,000 parts water makes a good disinfectant for the walls, but it must be handled carefully as it is a deadly poison. The ice chamber or bunker should be cleaned each year also.

(8) Keep the ice bunker well filled with ice.

(9) Avoid having the door open more than is necessary. A vestibule helps a great deal to keep the outside air out of the storage.

(10) There should be a false or rack floor laid over the regular floor and it should be put down in small sections so that it can be easily taken up and carried outside for cleaning. It also assists the circulation of air in some instances.

(11) Consult table for storage temperatures for various goods on page 31.

(12) Do not put too much warm food in storage at one time.

HARVESTING THE ICE CROP.

The ice crop every winter in Canada is an enormous one and if it could be marketed in the cities for summer use, the revenue would amount to many millions of dollars. The farmers must rely upon the ponds, rivers and lakes close by for their supplies, as it has not been found practicable to ship ice by rail. In some sections ice is not available as there are few, if any, bodies of water large and pure enough to produce the ice required, or else the winter weather is not cold enough to freeze water to a sufficient thickness. Farmers could make their own ice, weather permitting, by making a few ice moulds

close to the well and gradually freezing them full, or by making a solid block of ice in a metal-lined chamber by pumping into it a little water every day or so and allowing it to freeze solid. Twenty cakes of ice each 18 inches square and 12 inches thick would make a ton of ice as stored.

Still another method for manufacturing ice on the farm is to make an artificial pond where there is an abundant supply of water available from well or spring and pumping is done by power or hydraulic ram. The area required to produce a ton of ice is not great, depending of course upon the thickness of the ice. The following table may be found useful in determining the area necessary for a given amount of ice at various thicknesses.

Number of cakes of various thicknesses required per ton of ice (size of cakes, 22 inches by 22 inches).—(U.S.A. Farmers' Bulletin 1078.)

Thickness of ice	No. of cakes required per ton	Cutting space required per ton	Thickness of ice	No. of cakes required per ton	Cutting space required per ton
Inches		Sq. feet	Inches		Sq. feet
4	31.3	105.4	14	8.9	30.1
6	20.9	70.2	16	7.8	26.3
8	15.6	52.6	18	6.9	23.4
10	12.5	42.1	20	6.3	21.1
12	10.4	35.1	22	5.7	19.1

The same bulletin, on page 5, gives an interesting method of making ice at home. As we have not seen this method tried, we cannot give first-hand information about it, but it looks as if it would be quite workable. The following paragraph is a description of the method:—

"When cold weather prevails for several weeks at a time and the supply of pure water is limited, a method of freezing ice in metal cans or special paper bags may be used. The cans may be made in any convenient size by a local tinsmith, and should be of galvanized iron reinforced at top and bottom with iron strips. The bottom is made smaller than the top, to make the removal of the ice easier. The cans are placed near the water supply, filled with water, and left exposed to the weather. A shell of ice soon freezes around the inner surface, and when the shell is from 1½ to 2 inches thick, hot water is poured over the outside of the can and the shell removed. A hole is broken through at the top of the shell and most of the water inside is then poured out. As the freezing progresses water is poured into the shell a little at a time until a solid block of ice is produced. By this method only a few cans are required, which keeps the cost low. About the same method is employed when special paper bags are used, although they do not last so long as the cans. The advantage of the bags over the metal cans is mainly in cheapness, for they are not so convenient to handle."

The Usual Method.

The usual method of harvesting the supply of ice for the farms is to cut it from some near-by pond, stream or lake and haul it home, and store it in the ice-house or some form of enclosure where it is well covered up with dry sawdust. The source of ice should be free from contamination and clean of weeds and other vegetable matter for obvious reasons. The method consists of the following operations:

(1) Cleaning off the snow, if any, by means of a suitable form of scraper. The snow is either dragged off to the shore or pulled into windrows, depending on the size of the area.

(2) *Marking off the Ice into Squares or laying off the Field.*—This operation should be done accurately in order to have blocks of equal size and cut straight and even to make handling and packing in the house as economical as possible. Success in this depends largely on getting the first line straight and this can be

done by stretching a line between two stakes and placing a straight-edged board 12 or 14 feet long along the line, and marking the ice with hand tool or hand plow along the edge of the board. The board is moved along as the marking is done, piece by piece. Other methods equally good, or even better, may suggest themselves to those engaged in the work. After marking in one direction is completed it is necessary to establish a line across the area, which is perpendicular or at right angles to the first direction. Probably the best way to start this is by using a large carpenter's square made of pieces of straight-edge boards 10 or 12 feet long and tied across the corner to hold them fast at angle of 90°. Once the first line is marked straight and at right angles to the first lines, the rest can easily be marked off properly.

(3) *Cutting the Ice.*—The ice is cut both ways by either a horse-drawn ice plow (Fig. 13) or a circular saw driven by a gasoline engine, the whole mounted on a sled pushed along by hand (Fig. 14). The latter method of cutting is very satisfactory and is economical, when cutting is done on a large scale, as is the case with a large ice dealer or group of farmers harvesting their ice co-operatively. The ice field is usually cut in only one direction with the machine, and to a point two or three inches of the full depth. The long strips one way are detached from the field by striking into the saw cut with a heavy chisel, and then pushed up to the loading platform and there cut up into blocks by a hand saw or by the chisel in case the field has been cut both ways by the ice plow or power saw (see Figs. 15, 16 and 17). When a very small quantity of ice is harvested the cutting is done by saws operated by hand.

Loading the Ice.—There are several devices used for loading the ice on the sleigh, wagon or motor truck, depending on the amount of ice being handled. The main object in this case is to get a mechanical outfit that is cheap, convenient to operate and which will save the handling of the ice by hand. Figs. 18 and 19 illustrate two systems in common use, one suitable for a small outfit and the other for a large job.

Packing the Ice.—It is advisable to store the ice on cold, dry days, as it will be better for handling and will keep better after storage. (See Fig. 20.) The cakes should all be the same in size and evenly cut in order that they may be packed together with as little air space as possible. Any spaces should be filled with small pieces of ice. The more compact the mass of ice the better it will keep. Below the ice there should be a foot of dry sawdust or shavings, and as the filling proceeds the same material should be packed between the ice and the walls. Do not put sawdust about the individual cakes of ice. Pack the ice with a little dip towards the centre so that it cannot press outwards against the walls. After the ice is stored there should be a couple of feet of sawdust put over the top.

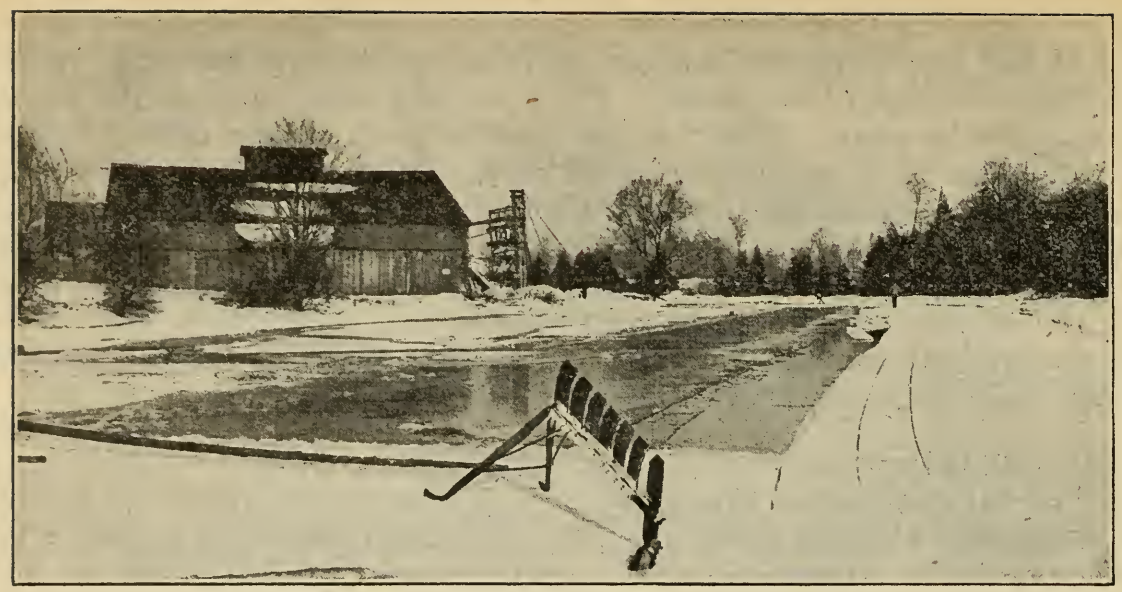


Fig. 13.—The Iceplow and Its Work.

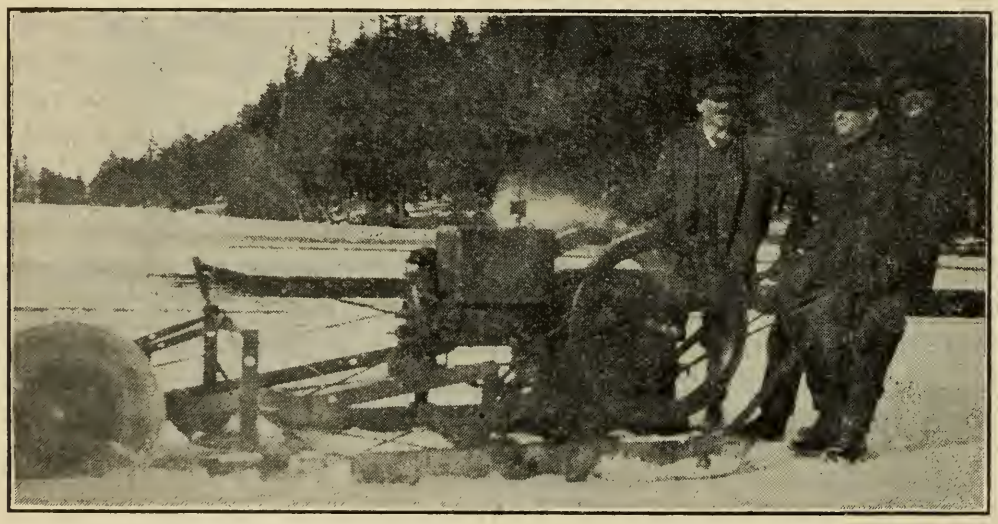


Fig. 14.—Cutting Ice with a Circular Saw driven by a Gasoline Engine.

Fig. 15

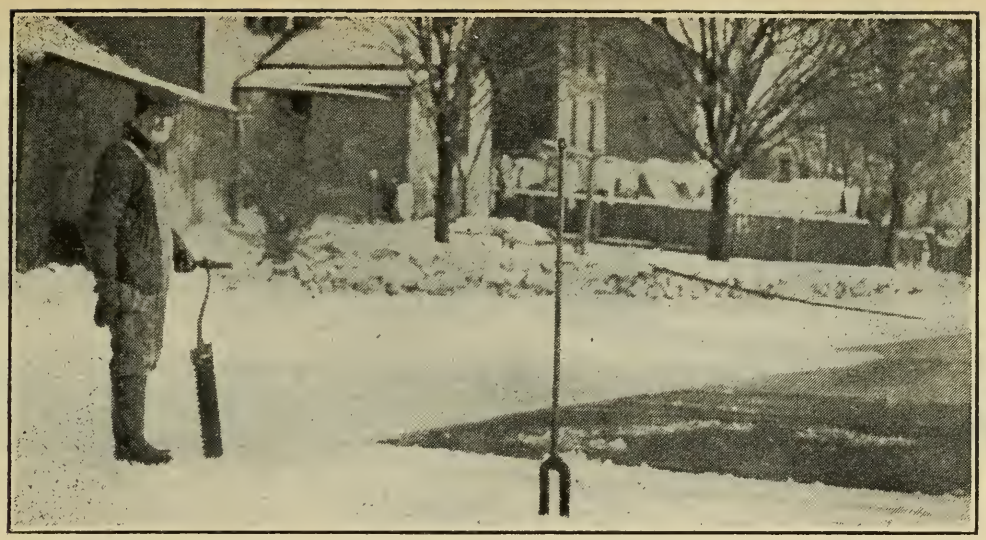


Fig. 16

Fig. 17

Fig. 18.—Loading Ice.

Fig. 19.—Loading Ice.

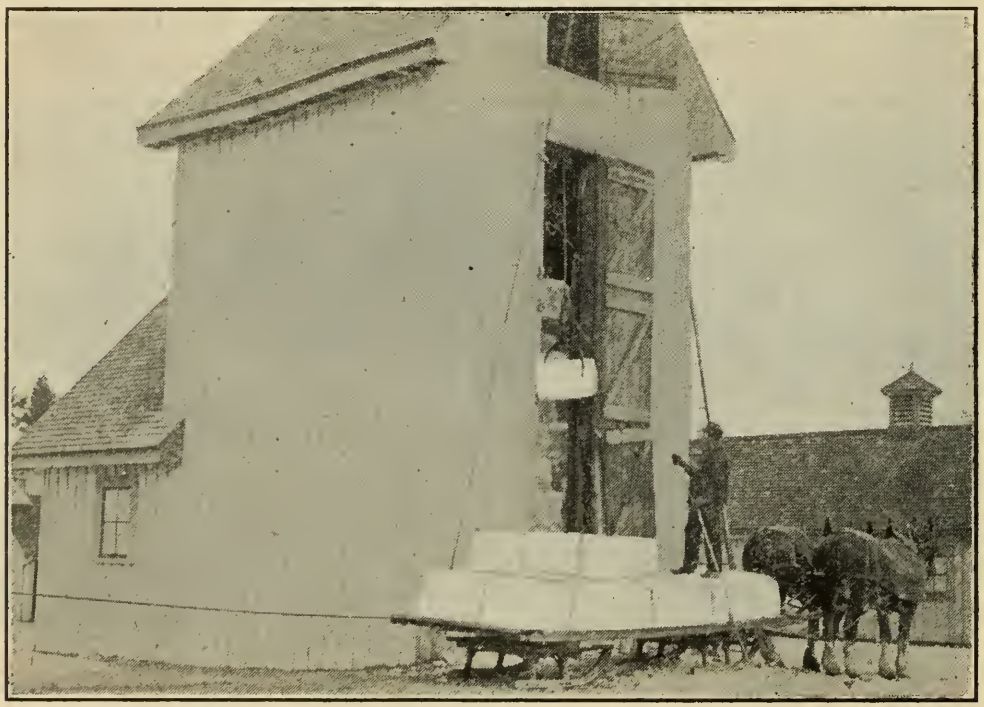
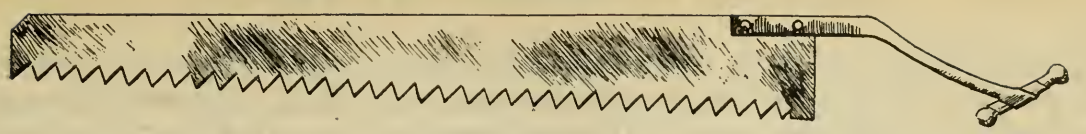


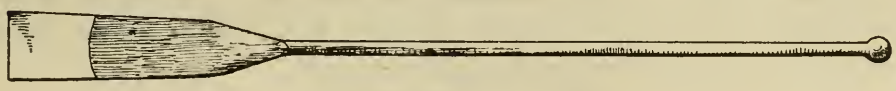
Fig. 20.—Storing the Ice.

TOOLS.

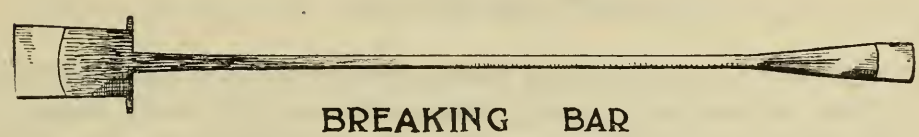
The kind and number of tools required for harvesting ice will depend on the amount of ice harvested and local conditions for handling ice. The best way for the farmers to handle this work is to do it co-operatively and then they can afford to get a good equipment which would greatly expedite the work. For harvesting a small quantity of ice there would be required two ice saws, 1 hand marker, 1 pulley and rope, 2 pairs of ice tongs, 2 ice hooks, 1 pointed bar or splitting fork and 1 straight edge. To these might be added with great advantage a horse plow and marker, horse scraper and a caulking bar. Many commercial ice dealers now use power for cutting and loading the ice and hoisting it into the storage. The accompanying drawing, Fig. 21, illustrates most of the equipment used, and all the tools can be secured from any hardware merchant.



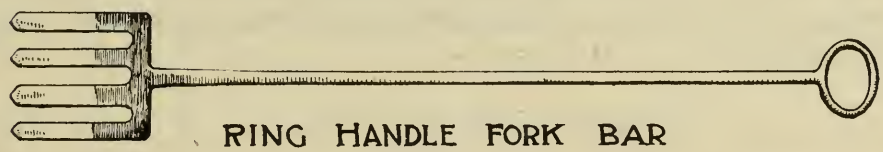
ICE SAW



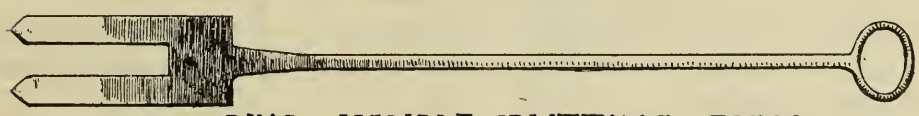
CAULKING BAR



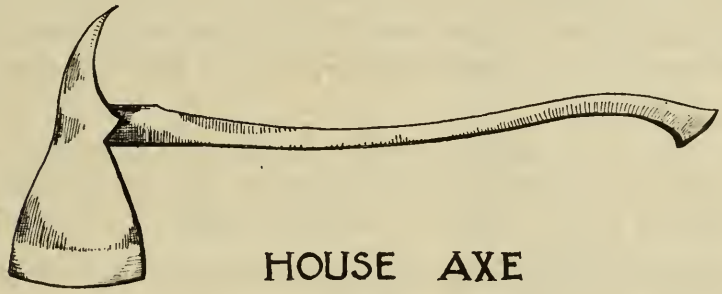
BREAKING BAR



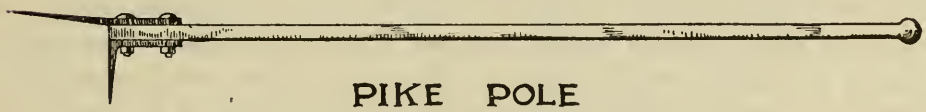
RING HANDLE FORK BAR



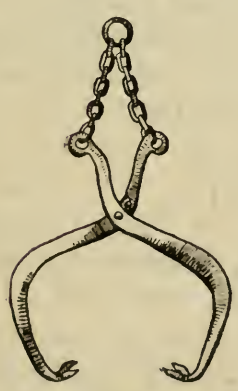
RING HANDLE SPLITTING FORK



HOUSE AXE



PIKE POLE



HOISTING TONGS

EDGING UP TONGS

FIG. 21.—Tools for Handling Ice.

NOTES ON INSULATING MATERIALS.

Materials which are poor conductors of heat, and are otherwise suitable for using in the construction of insulated walls, are called insulating substances. There are many different uses of these materials to-day and from time to time new substances are being tested out and added to the already long list. The Department of Physics has recently tested the insulating value of several substances, and as some, at any rate, are of interest and value to the farmer, the results of our tests in a general way are given below.

Summary of Results.

Substances Tested.—Very fine (dust form) black regranulated cork, chopped straw, coarse black regranulated cork, forest leaves (old, well dried), forest leaves (new, well dried), granulated cork (natural colour), sawdust, excelsior (fine form called wood wool), planer shavings, flax fibre, wood pulp, and sphagnum moss (well dried).

Comments on Results.

1) A substance to be a good insulator must be a poor conductor of heat, but all poor conductors are not suitable for insulators. Nearly all the substances tested above are poor conductors of heat, fine cork dust being the poorest, and wood pulp the best conductor.

(2) A good insulating substance is also a poor absorber of moisture, is not subject to spontaneous combustion or destruction by rot, is not attractive to rats and mice, in case it is a filler it does not settle in the wall, is easily handled, is durable. It may or may not be high-priced, but as a rule the best insulating materials are pretty costly.

(3) All insulating materials used in walls should be adequately protected on both sides from moisture by water-proof papers in case of wooden walls, and by asphalt paint in case of stone, brick or concrete walls.

(4) Never use a water-proofing material that has any tarry odour, else the food stuffs stored in the rooms become tainted.

(5) For low or moderate-price insulated walls such as ice-houses, small ice-cold storages, bee-hives, iceless refrigerators, fireless cookers, etc., we would recommend planer shavings, either flax chaff or flax fibre, and granulated cork if one can afford it. Forest leaves, well dried, will give good results for a time and are all right for bee-hive insulation, but not for a permanent structure. Sawdust is quite good enough for packing about ice in the ordinary ice-house. Do not use it in permanent walls as it rots quickly and settles badly. Sphagnum moss if well dried and packed into the wall tightly will give very good results, we believe, provided it can be well protected from moisture. Its capacity for moisture is very great. As yet it can be secured only in limited quantities. Its adaptability to insulating purposes will be further investigated by us in the near future. Fine excelsior or wood wool did not test up very well as a non-conductor. If it were chopped up fine we believe it would give very good results. The quality we tested is much finer than that ordinarily used in packing boxes. Wood pulp gave the poorest results of any of the substances tested. We attribute this to its greenness, although it was dried pretty thoroughly. It has a tendency to pack too tightly and lacks that elasticity so essential to a good insulating filler. Chopped straw or hay give excellent results, but its durability is an

uncertain property owing to its attractiveness to rats and mice. If this difficulty could be overcome, chopped straw would boom as an insulator. Cork has proved to be a very high-class insulating material for walls of cold storage buildings, tanks, steam pipes, beehives, etc., but it is too costly for general use. It is used in two forms, the loose or granulated form for packing into wall spaces and the compressed or board form for applying to interior surface of high-class cold storage rooms having exterior walls of stone, concrete or brick.

COLD STORAGE AND FREEZING TEMPERATURES.

The best suitable temperatures for the storage of any product depends somewhat upon its condition when stored, length of time to be stored, condition of air circulation, and humidity in the storage room, etc., but the temperature given in the following table for the various products and articles named are bound to be about the average of the best present practice in cold storage work:

Cold Storage and Freezing Temperatures for Various Products.

Products	Deg. F.
Apples	30
Asparagus	33
Berries, fresh (few days only)	40
Bulbs	34
Butter	14
Cabbage	31
Canned fruits	40
Canned meats	40
Carrots	33
Celery	32
Cheese (long carry)	35
Cider	32
Corn (dried)	45
Cream (short carry)	33
Cucumbers	38
Currants (few days only)	32
Cut roses	36
Dried beef	40
Dried fruits	40
Eggs	30
Fish, fresh water (after frozen)	18
Fish, not frozen (short carry)	28
Fish (to freeze)	55
Fruit trees	30
Fur and fabric room	28
Game (after frozen)	10
Game (short carry)	28
Game to freeze	0
Grapes	36
Hams (not brined)	20
Hogs	30
Ice cream (few days only)	15
Maple sugar	45
Maple syrup	45
Meats, fresh (ten to thirty days)	30
Meats, fresh (few days only)	35
Meats, salt (after curing)	43
Milk (short carry)	35
Nursery stock	30
Onions	32
Parsnips	32
Peaches (short carry)	50
Pears	33
Peas (dried)	45
Plums (one to two months)	32
Potatoes	34
Poultry (after frozen)	10
Poultry, dressed (iced)	30
Poultry (short carry)	28
Poultry (to freeze)	0
Sauerkraut	38
Strained honey	45
Sugar	45
Syrup	45
Tomatoes (ripe)	42

RELATION OF THE COOLING POWER OF ICE TO THE COMMON PRODUCTS OF STORAGE.

If we know the specific heat of a substance, that is, the amount of heat required to raise the temperature of a unit mass of the substance one degree, relatively to water, we can determine the quantity of ice necessary to cool a definite weight of that substance to any desired temperature. In the table below is given the quantities of some common products that are cooled 35 degrees

by 100 lbs. of melting ice. The temperatures, 75 degrees before storage, and 40 degrees in storage, are not used as being correct for all cases, but as being convenient and well within the cooling power of ice. Water is included merely for the sake of comparison as the specific heat of all substances is relative to it.

Name of Product	Specific Heat	Probable temp. before storage	Temp. in storage say	Fall in temp.	The number of lbs. of each product cooled 35 degrees Fahrenheit by 100 lbs. of ice.
Water	1.00	75	40	35	428.5
Skim milk	.95	75	40	35	451.05
Fruit (fresh)	.92	75	40	35	465.8
Vegetables	.91	75	40	35	471.2
Milk	.90	75	40	35	476.1
Cream	.84	75	40	35	510.12
Fish (fresh)	.82	75	40	35	522.6
Poultry	.78	75	40	35	549.4
Eggs	.76	75	40	35	563.9
Beef (fresh)	.68	75	40	35	630.2
Mutton	.67	75	40	35	639.6
Pork (fresh)	.51	75	40	35	640.3
Butter	.64	75	40	35	669.6
Cheese	.64	75	40	35	669.6

Note.—In these results observe that water is the hardest to cool, then the fruits and vegetables, which contain a large percentage of water, and easiest of all is the pork. Since the fruits and vegetables cool so slowly they are, therefore, more apt to spoil under normal conditions, and require to be well cared for early after harvesting. The water in them holds the heat and renders cooling very slow. These results indicate approximately the quantity of ice necessary for the cooling of the above amount of these products, provided that the heat is abstracted from the products alone, and therefore this table serves as a rough guide in calculating the amount of ice required for any particular case. In most of our small ice storages there is a loss of 25 per cent. to 50 per cent. cooling power due to poor insulation.

REFERENCES.

The following is a list of bulletins on Cold Storage, published by the Dairy and Cold Storage Branch, Department of Agriculture, Ottawa. All are free and may be secured by writing to above address:

1. The Cold Storage of Food Products, No. 44.
2. Small Cold Storages and Dairy Buildings, No. 16.
3. Precooling, Shipment and Cold Storage of Tender Fruit with notes on Packing and Packages, No. 48.
4. The Grimsby Precooling and Experimental Fruit Storage Warehouse, No. 47.
5. Cherry Precooling Possibilities.
6. The Use of Brine Tank Refrigerator Cars for Fruit Shipment, No. 50.
7. The Rate of Precooling Fruit in different Styles of Packages and at different Temperatures, No. 51.
8. Simple Methods for the Storing of Ice, Pamphlet No. 2.
9. The Cooling of Milk for Cheese Making, No. 22.
10. Re Creamery Cold Storage Bonuses, Circular No. 6.

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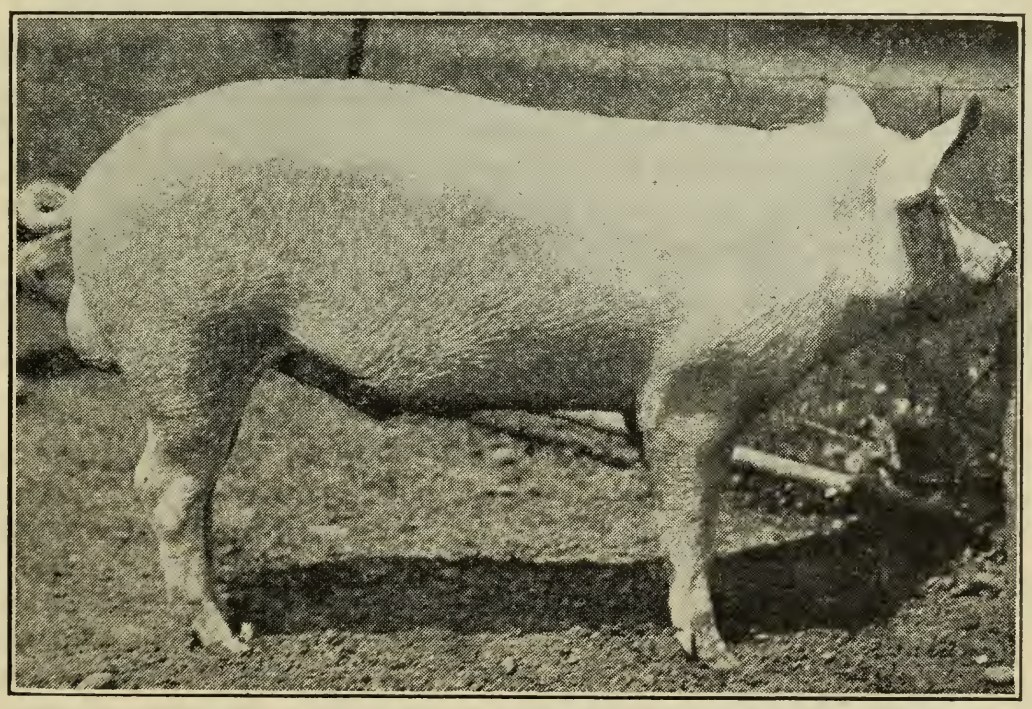
SELECTION, CARE AND MANAGEMENT OF THE BOAR

By R. G. Knox, B.S.A., Lecturer in Animal Husbandry

INTRODUCTION

Canada must prove her claim to a place on the British market by demonstrating her ability to consistently produce the quality of product which is in demand, and to maintain a more or less constant supply of that product. The motto for Canadian hog raisers at present should read, "more select hogs," rather than more hogs. At such time as the standard of type and quality of the live hog has been raised to the point where the manufactured product from it displays something like uniformity, we may sanely endeavour to increase the hog



Emperor, O.A.C. 4.—86446. Yorkshire boar—8 months—Junior sire, O.A.C.

population of the country. During 1923, of all hogs marketed in Canada, only one in every eight graded select. Comparison with the hogs of Denmark, where they grade over 80 per cent. select, emphasizes the urgent necessity for serious thought and determined action on our part.

Recent prevailing prices have not tended to stimulate increased interest among those who could not, or would not see beyond a temporary depression, and have been disposed to quit the business because there was no money to be made at it. If future prices should appear to warrant a profit, many of these men will re-engage in the hog-raising business. The policy of jumping in and

out of hog breeding is an old one, and, moreover, one which has been a serious menace to the successful development of the hog industry in Canada. Irregularity of supply is a stumbling block to the creation of a steady demand.

However, to those who have the courage of their convictions and have confidence in the industry, the problem of developing the Canadian bacon hog industry is a national one. Its salvation must be worked out. Canadian hog raisers are called upon to do their share. Persistency of purpose and stability of endeavour should appear on every swine breeder's calendar.

What effect recent changes made in the weight of hog grades will have remains to be seen. It is to be hoped that the tendency to market unfinished hogs will be discouraged, and that hog feeders throughout the country will realize that a hog of "thick smooth" conformation will not hang up a Wiltshire carcass if he is marketed when unfinished. Length, smoothness, quality, balance and finish are essentials to a bacon type hog. The first four are secured mainly through breeding, and the last is accomplished only by feeding. A good type hog may be ruined by injudicious feeding, but good feeding cannot convert bad type into good.

Too much emphasis cannot be placed upon the importance of the type and calibre of the breeding stock maintained in our Canadian breeding herds of swine. Present day prices for good pure-bred boars overcome any excuse for using grade boars even on grade sows. The foundation stock must be as nearly right as possible. Like begets like. Without real vigorous, strong constitutioned and good-feeding breeding stock from strains which are prolific and of bacon type we cannot expect maximum returns from our finished hogs. Mortality in young pigs ravages profits. The narrow-chested and shallow-bodied hog is a poor feeder and a costly boarder. Moreover, he is more susceptible to disease than the strong constitutioned hog. The sow raising small litters costs nearly as much to maintain as does the sow raising large litters and hogs of the right type, fed judiciously, command the premium.

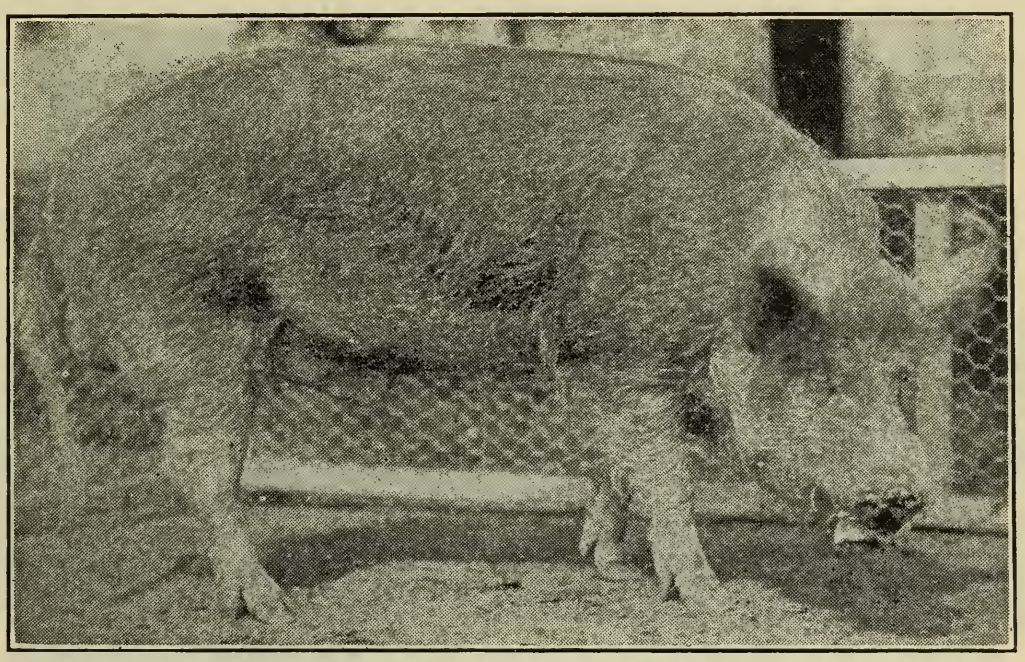
SELECTION OF A BOAR

When selecting a boar, the prospective purchaser should keep in mind that the influence of that boar is bound to make itself felt not only on the progeny of his own breeding herd, but also on those of the community from which the sows come for service. Consequently, a man buying a boar assumes considerable responsibility as to the quality of the pigs which will be marketed while his boar is standing for service. The reflection is comparatively rapid and a great deal of harm can be done in a very short time. A desire to improve the breeding stock should always be uppermost in a man's mind and the best is never too good. Even with rigid selection there are bound to be a few undesirables cropping up. A poor boar at any price is a very unsound investment, and good boars do not command a prohibitive premium at present.

It is not a wise policy in the majority of cases to practise too close breeding with hogs. Whenever possible, an unrelated or distantly related boar is to be preferred to a boar which is closely related to the sows with which he is going to be mated. While the breeding of closely related hogs may be warranted in an attempt to establish a type or some special characteristic more firmly in a particular strain of hogs, there is the danger of accomplishing such with the forfeiture of the strength of the constitution of the hogs, quite often getting extremes and lack of vigour, rendering them more susceptible to the ravages of disease.

Every boar used in Ontario should be of bacon type and should be typical of the breed of which he is a representative. Outside of a few corn-belt counties we have no place for any type of hog other than bacon. True, there are some lard breeds which are being made over, as it were, and which have been improved considerably, but why spend time at this work when we already have breeds of hogs of the right type? All effort at improvement and development should be made with the recognized bacon type breeds.

There are many old proven boars throughout the country which are discarded from year to year and sold to the butcher before their period of usefulness is over. This is a serious mistake. A proven sire which is breeding reliably, should always command first consideration. A partially matured boar is more desirable than a very young one, since there is a more reliable indication of what his individuality will be when mature. There is, also, a better indication of the growth and development in the case of the partially matured boar.

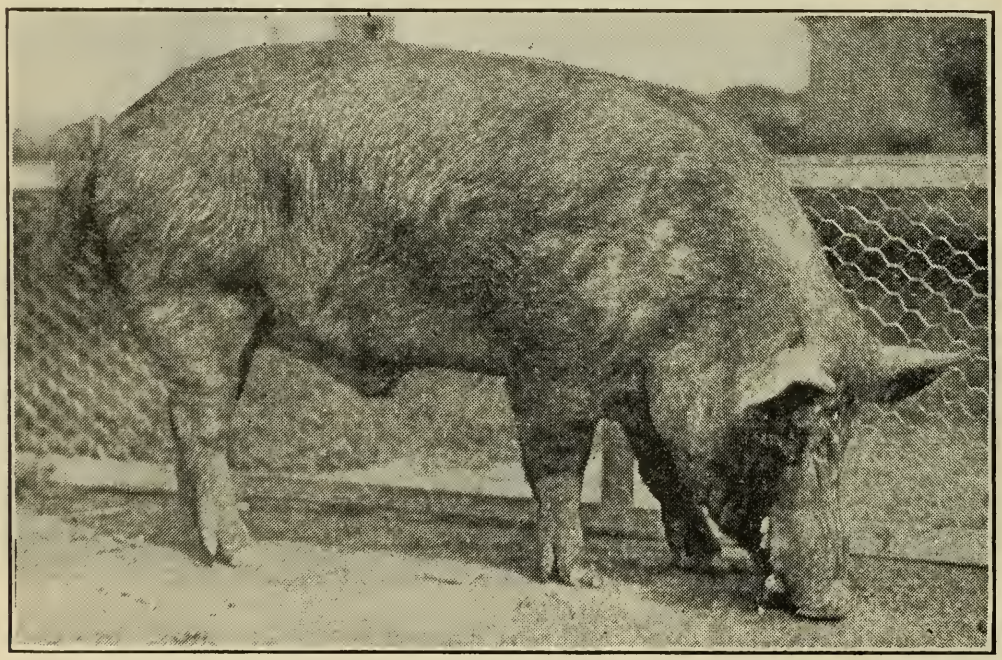


Three-year-old Yorkshire boar. Appleby Champion—99020—Senior sire—O.A.C.

While it is of utmost importance that the boar should be of bacon type, his breed identity should not be lost sight of. He should conform to the best type of the breed of which he is a representative and display an abundance of breed character.

As to individuality, a boar should carry a balance of body. He should have length, trimness, smoothness and quality, and should show a reasonable amount of arch of back. He should have a clean-cut head with good width between the eyes and at the poll; the shape, texture and setting of ear as well as the expression about his head should be typical of the breed to which he belongs. The jowl should be firm and trim. His neck should be of medium length and muscular. The shoulder should be neatly set into the body with the shoulder blades well filled between with muscle. A boar should have a sufficient depth of body along with width of chest floor to insure a strong constitution. Without that strength we cannot expect best feeding results. However, it is not necessary for him to have such depth as we demand in a brood sow; a boar with medium depth of body crossed with good deep sows usually gives satisfactory feeding pigs. His side should be of good length and flat, with the rib coming

out from the backbone sufficiently far to give him width enough to allow for internal organs to develop and function properly. The loin should be deep and strong, and as wide as the rest of the back, and his rump should gradually slope to the tail head, being slightly rounded from side to side over the top with no indication of coarseness or flabbiness in that region. He should be just as deep and full at his rear flank as at his fore flank, which, with a trim belly line, should give him a full and practically straight underline. His ham should be smooth and firm, with the flesh carried well around the bone and tapering toward the hock. Great flabby, bulging hams are not wanted on a bacon hog. If a straight edge were to be laid along his side it should touch at every point. Of course, a boar at heavy service will, in time, develop a coarseness and heaviness about the shoulder which cannot be avoided, but a young hog should show this straightness of lines. As to quality and quantity of bone, the breeding boar should possess clean, strong bone, with no indication of coarseness about his joints, and he should stand straight and square on his feet. Any tendency toward weakness of pasterns is very undesirable. His hair should be of reason-



Maplehurst Defiance—15286. Tamworth herd sire, O.A.C. Note type and size for age.

able quantity and of good quality. Coarse, curly hair on a bacon hog is not indicative of quality. Extremes are to be avoided. The razor-backed hog is not a bacon hog. Neither is the narrow-chested, shallow-bodied, extreme hog an economical pork producer.

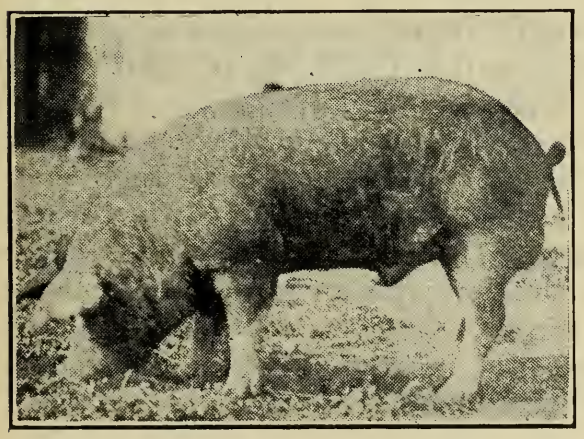
The boar selected for breeding purposes should be well developed for his age, strong, husky and, above all, should have a masculine appearance. A boar may have a real masculine head and still not have a coarse head. Moreover, he should have a masculine carriage about him. A feminine appearance in a boar is strictly objectionable. Masculinity and strength go hand in hand with prepotency. When selecting a boar it is a wise policy to pay a visit to the seller's herd where one is afforded an opportunity to see for himself the kind of stock he is breeding. If unable to make a personal inspection the next best thing is to make enquiry. In all bacon breeds of hogs, as stated before, there are hogs and hogs, and experimental work has gone to prove that as far as economy of pork production is concerned there is more in the strain of hogs

than in the breed. Prolificacy is of vital importance. Evenness of litters should not be lost sight of. Nor should the general vigour, health and thrift of the herd be overlooked. Uneven litters are one of the chief causes of lack of uniformity in product.

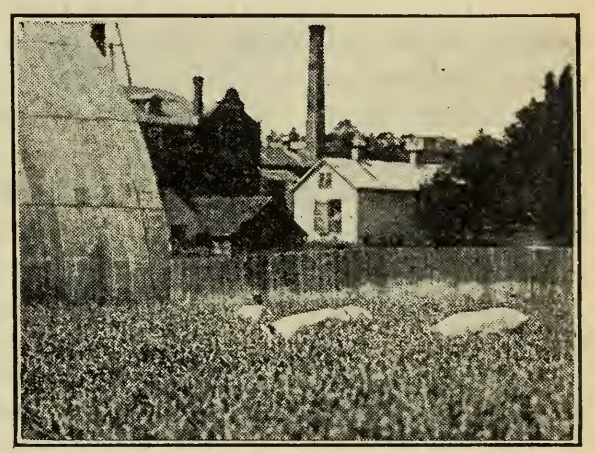
FEEDING AND MANAGEMENT

Exercise

Health, vitality and vigour are essential to a satisfactory breeding sire. Exercise is one of the main means of securing these requirements. Allowing a boar to run out in a small field or paddock sown to clover or annual pasture during the summer months not only cuts down the feed bill but also provides the hog with succulence and a variety of feed which tends to keep him in a healthy condition and also helps to maintain his feet in good shape. Exercise in conjunction with pasture during the summer months insures greater vitality and vigour, and in the case of the young hog promotes growth and development on a much lighter grain ration than where pasture is not provided. During the winter months a breeding hog should be out in a run every day if the weather



Berkshire boar, O.A.C.
Sandford Puddington—65314. 9 months old, O.A.C. sire.



Young pigs in peas and oats.
Exercise and green feed are necessary for the growing and breeding boars.

is at all fit. When practicable it is a good plan to feed the boar at some distance from his pen, thus obliging him to take exercise while walking back and forth to his sleeping quarters. Where more than one boar is kept, a good plan is to build two paddocks with a substantial wire fence dividing them. By this arrangement two boars may be turned out at one time, when they will parade back and forth along the fence challenging each other, thereby getting the necessary exercise. Care should be taken on the part of the owner that shade of some sort is provided in the event of the boar being obliged to stay out all the time during the summer months.

Growing the Young Boar

As soon as the young boar has been selected the aim of the feeder should be to grow him rather than fatten him. As mentioned elsewhere, exercise promotes growth and increases the strength of the young animal. Moreover, he has a keener appetite and will feed much better when allowed to run out a part of the time. Possibly, during the summer months, there is no more economical

and satisfactory method to develop the young boar than to turn him out on good clover pasture either in a paddock or pasture lot. An annual pasture such as peas and oats sown at the rate of 2¼ to 2½ bushels of oats and ½ bushel of small or 1 bushel of large peas to the acre, together with a mixture of clovers (red 8 lbs., alsike 3 lbs., sweet clover 4 lbs.) at the rate of about 15 pounds to the acre gives very good satisfaction. Pigs are turned into this crop when it is about 8 to 10 inches high. Rape is also a satisfactory crop to grow hogs on. Where an old boar is being maintained on the farm as well, it is easy to arrange for the sharing of the paddock between the two. If it is not possible to provide the pasture he should be liberally supplied with green feed in his pen. A certain amount of bulky, succulent feed is essential to good health.

For the young boar, recently weaned, there is no better feed than middlings and skim milk. However, finely ground oats and middlings are often used, and even a mixture of one-third middlings, one-third finely ground oats and one-third barley is often used to good advantage. In the growing of a bacon type boar it must be borne in mind that the right type of pig may be ruined by heavy feeding on barley, corn and other heating and fattening feeds just after weaning and before he is properly grown. All rations should be made up with the idea of promoting growth and the best growing feeds are: middlings, shorts, finely ground oats, skim milk, buttermilk, whey, tankage, the clovers (green), rape and roots. Heavy feeds too early in life tend to develop a roundness of conformation, shortness of side and encourage the laying on of fat instead of muscular tissue. The aforementioned feeds are rich in protein and so build bone and muscle rather than fat. After he reaches the age of five to six months the proportion of middlings (if expensive) may be cut down a little where dairy by-products are available at a reasonable price. Dairy by-products or tankage are more essential to a winter ration when green feed is not available. Mangels or sugar beets should always be included in the winter ration to supply succulency and variety. Roots are much relished in winter. They have a cooling, laxative effect, preventing constipation, and keep the animal thrifty and vigorous. A supply of mineral matter should always be available.

Feeding the Mature Boar

Keen observation and good judgment are required to keep a boar in good condition. Extremes are to be avoided. Thrifty condition means good condition. The over-fat boar does not make a satisfactory sire as a rule, and a half-starved boar cannot transmit vigour and constitution to his progeny to the same degree that he would if properly maintained. A reasonable amount of flesh will do him no harm if he gets sufficient exercise.

A ration of meal only is not satisfactory, nor should any concentrate ration contain too high a percentage of heating feeds such as corn or barley although combined with other feeds and fed along with a protein-rich supplement such as skim milk or tankage they give good results. Barley and oats mixed equal parts by weight and balanced with skim milk, buttermilk, whey, clover or alfalfa make a satisfactory ration. A great variety of grains may be fed, with judgment. As with the growing boar, roots should always form a part of the winter ration.

The quantity of meal to feed a boar will vary with circumstances. During the breeding season he will require liberal feeding. However, at no time should he be fed more than he will clean up in fifteen minutes. During comparatively idle seasons a light concentrate ration is sufficient, especially if the boar is on

pasture. Sudden changes in the ration are to be avoided at any season of the year. The following table shows results with winter feeding of the Ontario Agricultural College boars for two years:

WINTER MAINTENANCE OF BOARS, 1923

Boar	Age	Weight	Feed per day	Daily gains	Cost of feed per day	Cost of feed per 100 lbs. live weight per day	No, of services
Tamworth..	10 mos.	285 lbs.	chop.... 6.33 lbs. whey....16 lbs. mangels.. 3 lbs.	1.01 lbs.	11.6 cts.	3.1 cts.	4
Yorkshire	2 yrs.	446 lbs.	chop..... 6.51 lbs. whey.....16 lbs. mangels.. 2 lbs.	.44 lbs.	11.5 cts.	2.5 cts.	17
Old Yorkshire..	5 yrs.	485 lbs.	chop..... 6.51 lbs, whey....16 lbs. mangels.. 3 lbs.	.2 lbs.	11.9 cts.	2.4 cts.	10
Berkshire...	2 yrs.	615 lbs.	chop..... 5.5 lbs. whey....16 lbs. mangels.. 3 lbs.	.15 lbs.	11.5 cts.	1.8 cts,	9

Chop—Equal parts barley and oats, by weight, $1.40 per cwt.
Whey, 12½ cts. per cwt. Mangels, 15 cts. per bushel.
Nutritive ratio, 1 : 7. Average daily cost, 11.6 cts.

WINTER MAINTENANCE OF BOARS, 1924

Boar	Age	Weight	Feed per day	Daily gains	Cost of feed per day	Cost of feed per 100 lbs. live weight per day	No. of services
Tamworth..	22 mos.	510 lbs.	chop..... 4.5 lbs. whey....15 lbs. mangels.. 8 lbs.	.46 lb.	9.62 cts.	1.8 cts.	8
Yorkshire...	15 mos.	389 lbs.	chop..... 6 lbs. whey....15 lbs. mangels.. 8 lbs.	.74 lb.	12.87 cts.	3.09 cts.	21
Yorkshire...	6 yrs. 7 mos.	517 lbs.	chop..... 4.5 lbs. whey....15 lbs. mangels.. 8 lbs.	.001 lb.	9.62 cts.	1.89 cts.	5
Berkshire...	12 mos.	402 lbs.	chop..... 5 lbs. whey....15 lbs. mangels.. 8 lbs.	1.03 lbs.	11.37 cts.	2.59 cts.	7

Mixed Chop—Barley and oats, equal parts by weight, $30.00 per ton.
Whey, 12½ cts. per cwt. Mangels, 15 cts. per bushel.
Average daily cost of feed, 11.37 cts. Nutritive ratio, 1:7.13.
Average daily cost of feed for winters of 1923 and 1924, 11.33 cts.

All of the boars in the aforementioned tables were in a satisfactory breeding condition at the conclusion of the respective tests. The gains made by the younger boars were satisfactory and, as indicated by the tables, particularly that of 1924, the fact that the mature boar made a slight gain is indicative that the ration which they were getting was a fairly suitable one. It will be noted

that in the winter of 1924 more succulent feed and less concentrate feed was fed, which, in spite of the fact that mixed grain was higher in price in 1924 than it was in 1923, tended to reduce the cost of maintenance, and so far as observation as well as records would indicate, one was inclined to conclude that the ration fed during the winter of 1924 was a little more satisfactory than that fed in 1923 where the services were not too numerous.

Use

The age at which a young boar may be first used depends largely upon his development. As a rule, it is unwise to use a boar before he is eight months old, and one should only use him sparingly until he is well on to a year old. The discretion of the owner very often determines the length of the period of a boar's usefulness. Excessive use when young is likely to permanently injure his breeding powers, and the pigs produced will have a tendency to weakness and small size. Ordinarily, a mature boar should not be allowed to make more than one service a day with intervals of one or two days a week without being used. Where there is only one boar kept and outside sows are admitted there are certain seasons of the year when it is difficult to prevent the boar from being used too freely. Under no circumstances should more than one service to a sow be permitted. Some boars are naturally more vigorous than others and can settle a greater number of sows in a breeding season. The careful conservation of his breeding powers will insure an extension of breeding vigour in later life. The way a boar has been fed, the amount of exercise he is getting and the sanitary conditions under which he is kept have a great influence on his performance during the breeding season. A boar should not be used immediately after he has been fed, nor should he be allowed to run with the sows which are to be bred to him.

Removing Tusks

Armed with long, sharp tusks a boar is capable of inflicting serious injury upon man or beast should be become bad tempered or even excited, but deprived of his tusks he becomes quite harmless. It is wise, therefore, to remove these tusks before any damage is done, because one never knows what the quietest boar may do under provocation. Several methods may be employed to perform the operation. With any method it is necessary that the boar be made fast to a post or other solid structure by means of a rope noosed about his upper jaw back of the upper tusks. If a pair of bolt clippers are available the job may be quickly and satisfactorily done. Care must be taken to get the clippers close to the jaw and to see that no sharp points are left protruding. Another method is for one man to hold a crowbar or piece of iron with a sharp edge against one side of the tusk while another man operates with a sharp cold chisel and hammer. By placing the sharp edges on opposite sides of the tusk and then striking a good, sharp blow on the cold chisel with the hammer the job is done.

Trimming the Feet

The boar's feet should always be kept in good shape so that he is standing squarely and properly balanced. Lameness, broken-down pasterns and crippling are often the result of neglect on the part of the owner to keep the boar's feet properly trimmed. Even if allowed to run outdoors the horn of the hoof will grow unevenly and make the foot out of shape. A blacksmith's paring knife is quite suitable to do any small amount of trimming. However, if the

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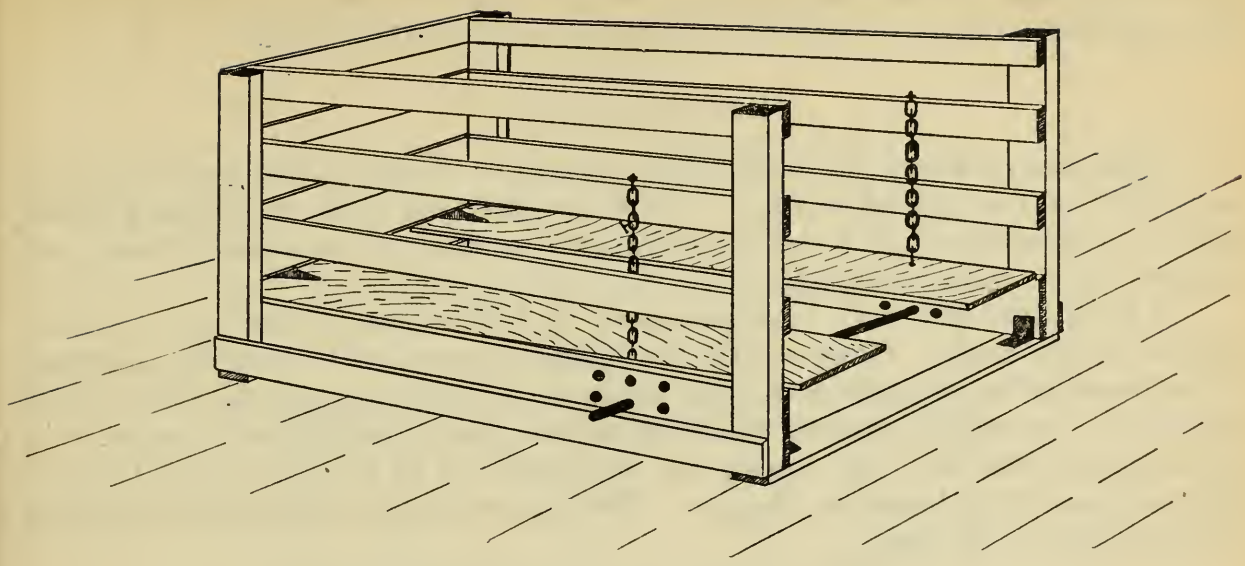

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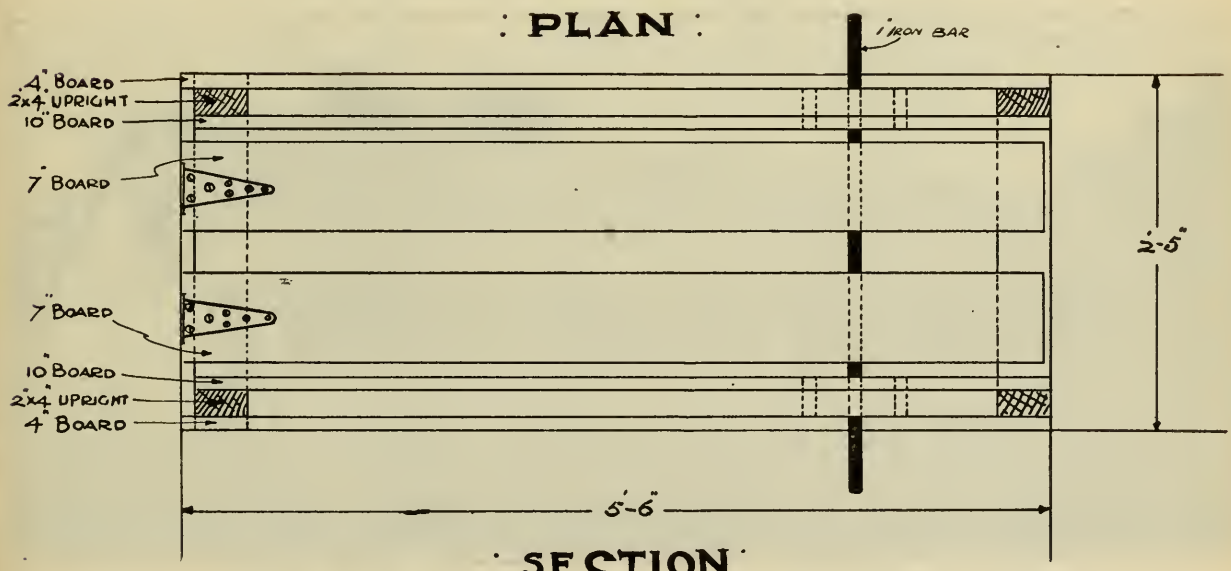

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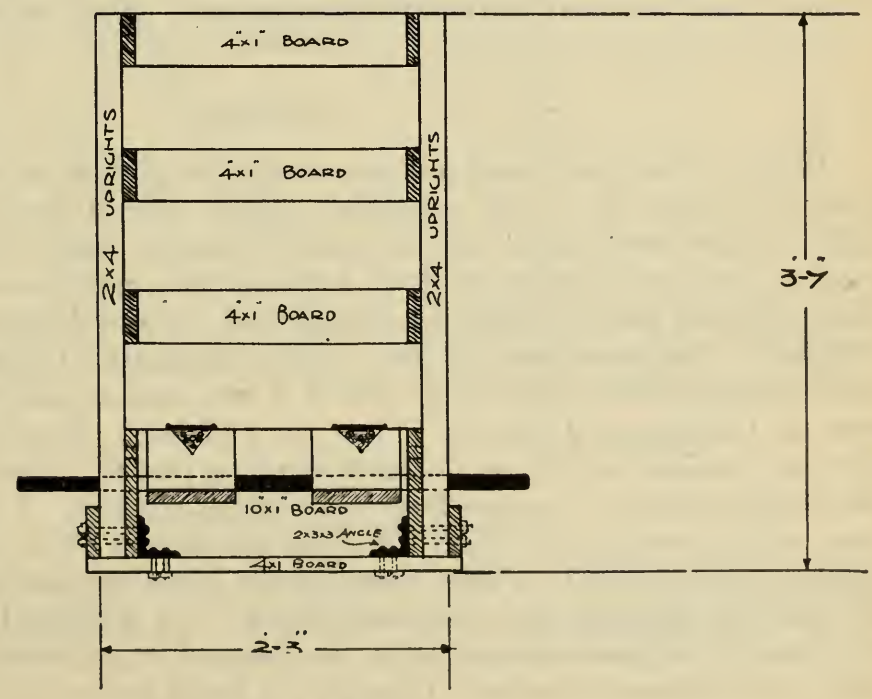


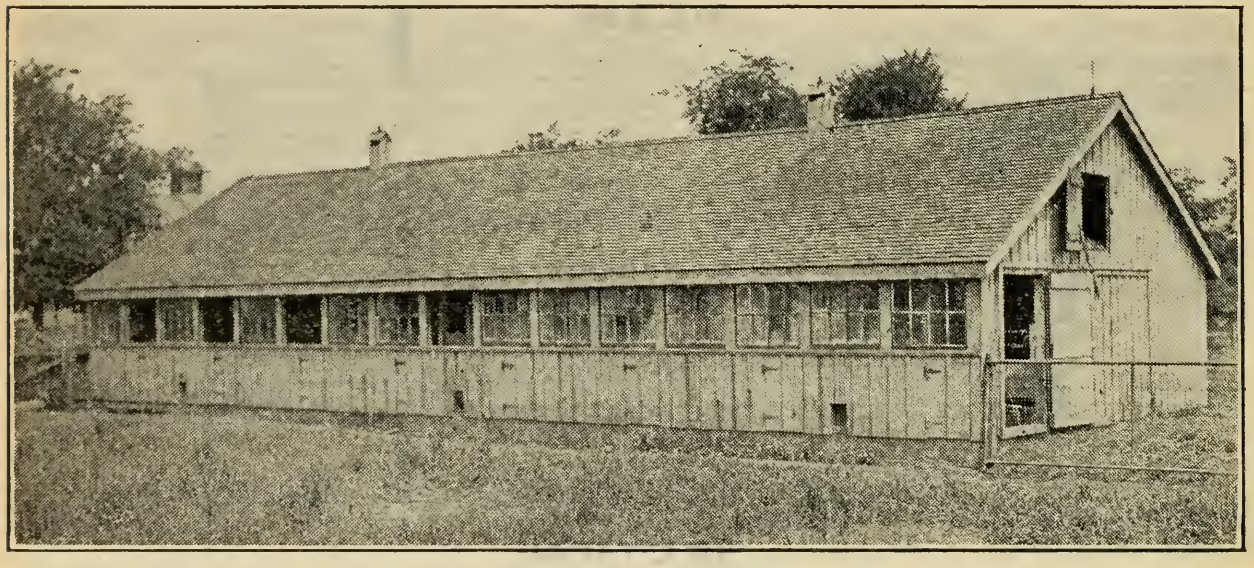
A BREEDING CRATE.

toes have grown very long a sharp wood-chisel and a mall may be used to very good advantage. The toes should be cut back and the horn on the side of the foot trimmed so that the animal is standing squarely on his feet.

Breeding Crate

When heavy boars are being bred to small or young sows a breeding crate may often be used to advantage. There are different types of breeding crates which are satisfactory, but the one shown in the illustration is easily made and answers the purpose very well.

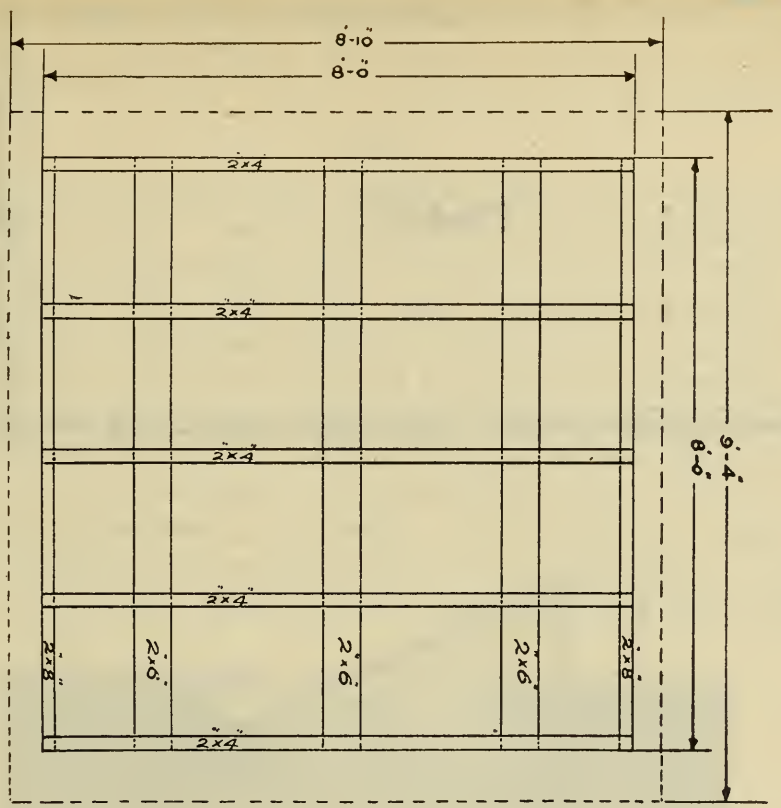
A little diffi ulty may be experienced at first to induce the boar to serve the sow in the crate. However, by first using the crate with an older sow that is not nervous, and exercising a little patience, he will learn that he is not being trapped in any way, and very soon will serve a sow as readily as if he were in open space. The two side boards are adjustable as to height so that little of the boar's weight is borne by the sow. The iron rod is also adjustable according to the length of the sow.

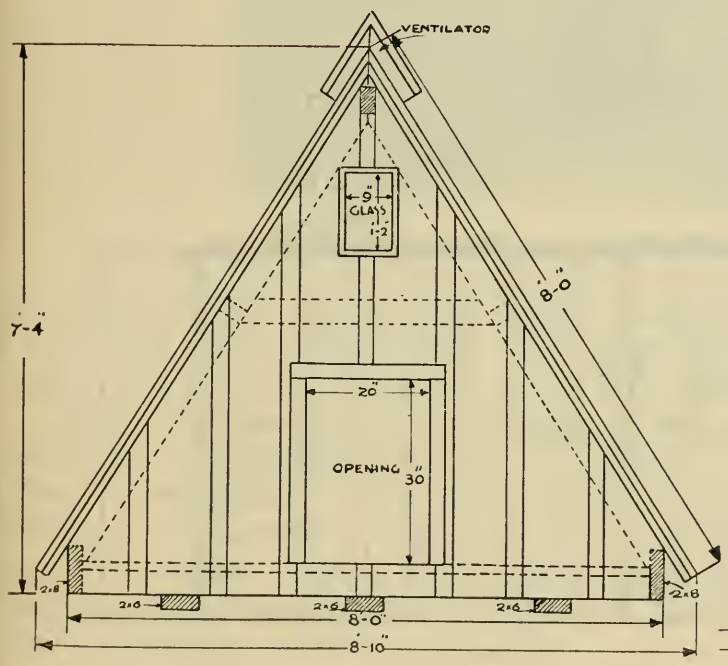


A suitable boar pen where a number of boars are kept. It pays to have boars by themselves if possible.

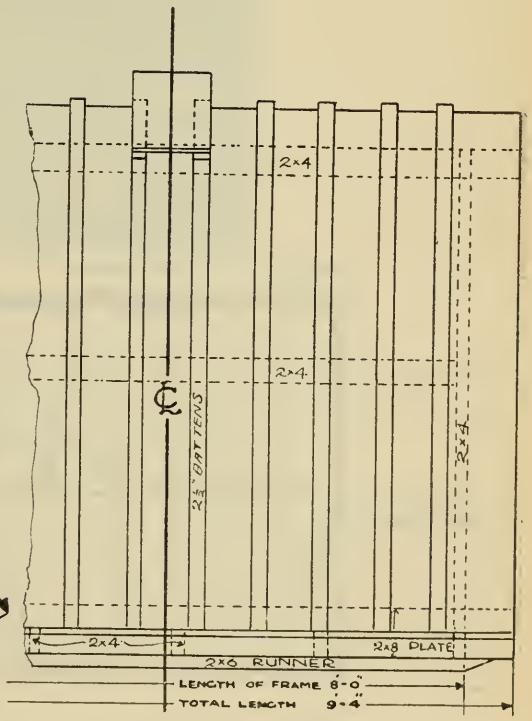
Housing

While a boar pen need not necessarily be elaborate and expensive in construction, there are a few essentials which should be common to any pen. Light, proper ventilation and drainage, freedom from draughts, provision for cleaning, and dry sleeping quarters are essentials which should be kept in mind. What shape it shall be may be determined by the dimensions of the building available. The boar pens at the Ontario Agricultural College are divided into two compartments; the outside pen is 9 feet square and the sleeping compartment at the rear is 7 feet by 9 feet by 4½ feet. The latter is covered with straw and makes quite a comfortable sleeping place. A pen of these dimensions will accommodate a mature boar quite satisfactorily. The flooring is of concrete, and is easily kept clean. A clean pen is just as necessary with a boar as with any other animal. Filthy quarters are often responsible for disease in boars and also for unsatisfactory breeding boars. An A-shaped pen or portable pen may be used to good advantage in the pasture lot to provide shelter and shade during the summer months. Likewise, it could be used in the paddock during





End Elevation.

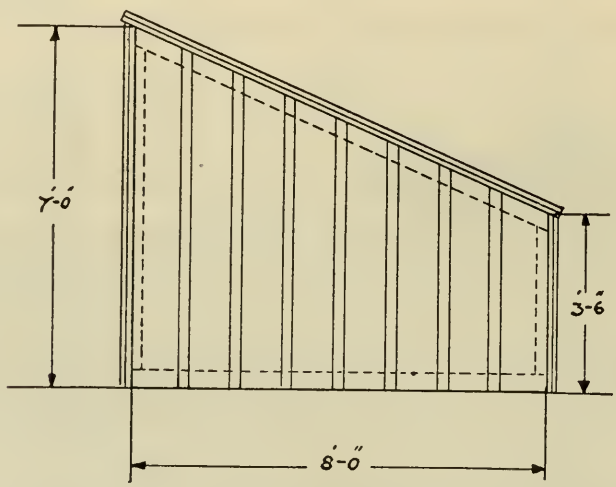


Side Elevation.

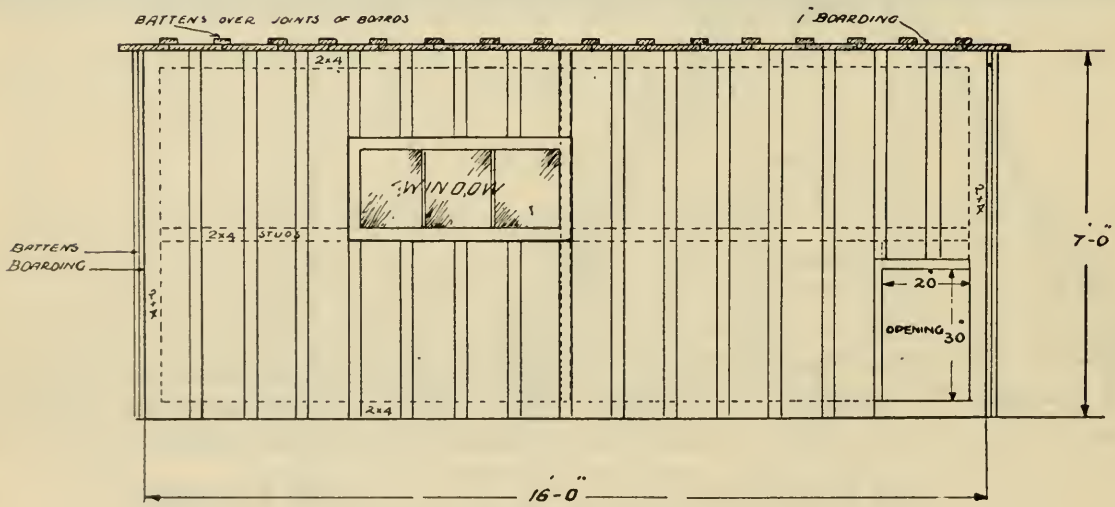
THE "A" SHAPED PEN

Bill of material for the construction

3 lengths of runners, 2″ x 6″ x 9′ 4″; 2 lengths of side boards, 2″ x 8″ x 9′ 4″; 5 lengths of scantling, 2″ x 4″ x 7′ 8″; 1 length of ridge support, 2″ x 4″ x 9′ 4″; 4 lengths of scantling, 2″ x 4″ x 7′ 6″; 2 lengths of scantling, 2″ x 4″ x 8′; 216 sq. ft. of 1″ boarding; 2 lengths, 1″ x 3″ x 2′ 6″; 2 lengths, 1″ x 3″ x 2′ 2″; 160 lineal feet of 1″ x 2½″ battens; nails, 4″ and 2½″.



End View.



Side View.

PORTABLE PEN SUITABLE FOR A BOAR.

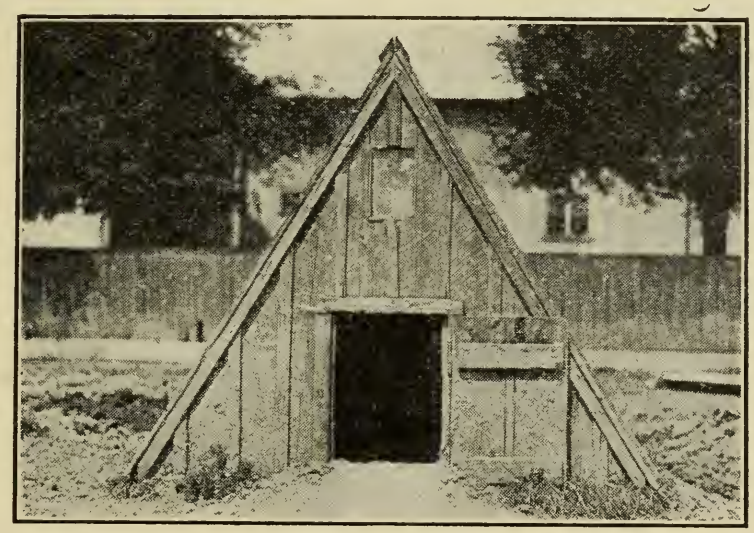
Bill of material for the construction of pen.

1 length scantling, 2″ x 4″ x 15′ 4″ long; 4 lengths scantling, 2″ x 4″ x 16′ long; 3 lengths scantling, 2″ x 4″ x 6′ 8″ long; 2 lengths scantling, 2″ x 4″ x 3′ 2″ long; 3 lengths scantling, 2″ x 4″ x 12′ long; 1 length scantling, 2″ x 4″ x 4′ long; 244 sq. ft. of 1″ rough boarding; 2½″ x 1″ battens, 400 lineal feet; 1 window frame, outside measurement, 4′ 3″ x 2′; nails, glass, etc.

early fall and late spring. Housing accommodation for the boar is most worthy of attention since, as stated before, the condition under which he is maintained has a determining effect on the length of the period of his usefulness.

Lice

Once a boar pen becomes badly infested with lice a good deal of effort is required to eradicate them. Boars are apparently very desirable hosts for these parasites, and lousy boars cannot give as good returns for feed consumed as those which are kept clean. Moreover, sows coming into contact with lousy boars carry lice back to other pens where probably there are young and growing pigs, which lice affect even more seriously than they do older hogs. As a rule the better known dips will prove effective if used according to directions. A two per cent. solution of creolin makes a fairly good treatment for lice. Coal oil is effective, but must be used with discretion because a heavy application will blister. Crude petroleum is splendid. Used tractor or motor oil is also very good. In applying any preparation care must be taken to wet all parts of the body with particular attention to the inside of the legs, about the ears,



The "A"-shaped house is good shelter for the boar.

in the folds of the skin and any part of the body where the lice most frequent. A half-done job is wasted time. The application can be made by means of a small broom or swab or, in the case of a dip, with a spray pump.

When lice have been in a building for some time it is necessary to thoroughly cleanse and spray with a mixture of one pint of crude carbolic acid to three gallons of whitewash. This is not only an insecticide but a valuable disinfectant as well. One application of insecticide is seldom sufficient because there will be many eggs to hatch out to give a new brood. A second treatment about a week or ten days after the first should always be given and very often a third treatment would be advisable.

Mineral Mixture

The following is the composition of the mineral mixture which is used at the Ontario Agricultural College and is giving good satisfaction:

4 bushels charcoal or hardwood ashes.
8 pounds salt.
2 quarts air-slaked lime.
1 pound sulphur.
10 pounds of bone meal.

This is kept in a box in the pen where the boar has access to it at will.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 308

The Culture of Early and Late Outdoor Tomatoes

By

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and

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Earliana Tomato.

TORONTO, ONTARIO, DECEMBER, 1924

A typical Earlianna vine.

Ontario Department of Agriculture

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THE CULTURE OF EARLY AND LATE OUTDOOR TOMATOES

FOREWORD

This bulletin has been prepared to meet the demands for information from the practical grower who is interested in the commercial production of tomatoes for both early and late crops. The aim throughout has been to set forth clearly a general outline of cultural methods as found most successful within the Province of Ontario. There is also included throughout the bulletin information of a more general nature expected to prove of interest to the growers of tomato crops.

The information presented has been obtained from various sources and the writers wish to acknowledge the valued assistance given by different men throughout the Province engaged in the industry. To those growers who gave the benefit of their experiences in growing the crop and to those men connected with the canning industry with whom the subject was discussed, the writers are indebted. References dealing with the subject of tomato growing were consulted as well and, in addition, use was made of the experimental work conducted under the Vegetable Branch of the Ontario Department of Agriculture.

The writers also wish to acknowledge the co-operation of Professor J. E. Howitt, of the Department of Botany, and of Professor L. Caesar of the Department of Entomology of the Ontario Agricultural College. Their respective contributions to the bulletin appear under the headings of "Common Diseases of the Tomato" and "Insects Attacking Tomatoes."

THE EARLY TOMATO CROP

It is the intention, in this section of the bulletin, to deal with the early crop of outdoor tomatoes. The information presented is that which will apply in those parts of Ontario where the production of early tomatoes is carried out on a commercial basis. The industry has been studied in these districts and much credit is due to those growers who have so generously given their assistance in various ways in the gathering of the information presented.

Wherever market gardening or truck farming flourishes two crops of tomatoes will be found growing, an early and a late crop. However, the sections which produce the main bulk of the early commercial crop are confined to the more southerly parts of the Province in close proximity to the Great Lakes which they border on.

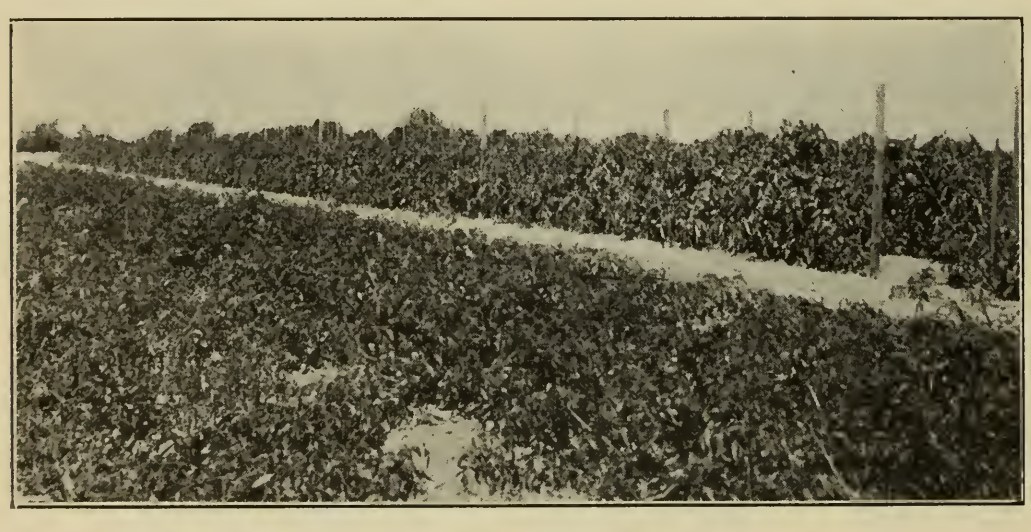
Essex County, with Leamington as a centre for early tomato growing, usually starts to make the first shipments of the season. The district extends from just east of Leamington and follows the light, early land along the Lake Erie shore line through Ruthven and Kingsville to Harrow and the surrounding district. There is also a considerable area where this crop is grown northwest of Leamington toward Olinda and Cottam.

The land used is either sandy loam or gravel loam soil, being part of a ridge or height of land running through the southern part of the country. Much of this land has a favourable southern exposure as well.

The Blenheim district in the southern end of Kent County is a less widely-known district. It is located in the same ridge of land as that running through Essex County and is close to the lake. The area suited to early crop production is not so extensive as at Leamington, but early tomato growing has become an important industry in this part of the county.

These two districts are about the same for earliness and in this respect are usually considered to be from one week to two weeks ahead of the other large producing districts which market commercial quantities of early tomatoes. Shipments normally start about the first week in July from the above sections.

Following along the lake shore counties there are small sections where the early crop is grown to some extent. In Norfolk County, around Simcoe, the industry is developing in a small way. The Niagara district from the vicinity of Niagara Falls and through along the tender fruit belt produces a large proportion of the Ontario crop.



Prostrate and staked methods of culture of tomato crop.

The Burlington district and surrounding sections are also large producing areas of this early crop.

In both of the above sections the land suitable for producing very early crops lies in comparatively small areas and hence the growing of the tomato crop is fairly well scattered throughout these districts.

This branch of truck farming is becoming more of a specialized business year by year. It represents a large annual turnover of money to those growers who are in the business. A large amount of capital is invested in the land and equipment, including greenhouses, used for producing the crop. Markets are constantly being extended and enlarged until now large shipments are made into the western markets as well as to those in the east. The business of early tomato growing in Ontario appears to have a good future ahead of it and considerable development is predicted within the next few years.

Soil and Site

For the early tomato crop soil requirements are more definite than for the late crop. The soil must necessarily be of a light type and such that it will dry out and warm up early in the spring. Sandy soils, sand loams and gravel loams are the types found where early tomatoes are grown.

A more or less sheltered site is usually chosen for this crop and under best conditions a southerly slope is used, though it is not unusual to see a crop successfully grown on what appears to be a rather exposed, almost level situation. The wind, whipping the vines about, especially in their early growth, is often hard on them and growth is liable to be checked somewhat also, so some shelter is preferable.

Soil Requirements and Preparation

The land for this crop should be in a high state of fertility, should be well drained and have a high humic content. It is very necessary that the land be in such a condition that it will hold and retain the maximum amount of moisture and this result can only be favourably obtained through having an abundance of humus present.

To keep his land in fit condition is one of the problems of the tomato grower. He must study the problem to seek a solution which will fit in with his farming system. Cover crops and green manuring crops plowed under are the greatest of aids, along with what manure is available, for in the early districts manure is expensive and becoming increasingly hard to obtain.

One very successful grower has been able to keep his soil in good condition on a two-year rotation conducted as follows: Tomatoes are followed by a crop of rye, which is plowed under the following spring, and twenty pounds per acre of sweet clover is seeded with a spring grain crop. The sweet clover makes a fairly good growth by fall when it is top dressed with about 600 pounds of precipitate phosphate and plowed under. The land is then worked up and sown to rye, using an additional application of precipitate phosphate at the rate of about 125 pounds per acre sown with rye. In the spring, before the rye becomes woody, usually about May 1st, it is plowed under and the land put into the best possible tilth ready to receive the crop. A further application of phosphate flour is made at the rate of 125 to 150 pounds.

Alfalfa sod is often plowed under and sown to rye in a similar manner. Any of the legumes are of great value when treated this way. The rye is able to take up much valuable plant food during its growing season, which would otherwise be lost through leaching in the fall and spring of the year. Besides this important service the rye adds materially to the supply of organic matter in the soil after being plowed under and helps to place much plant food ready for the use of the following crop.

Other growers practise a system of crop rotation whereby they follow the tomato crop with a cover crop of rye and vetch. This crop is later heavily manured and plowed under the following spring for a vine crop or one which can make the best use of the manure. This crop in turn is followed by rye and vetch with which is sown 500-700 pounds of acid phosphate, or one of the phosphatic fertilizers in a proportionate amount, and this crop in turn is plowed under the following spring in preparation for the tomatoes.

When any cover crop is used the sowing should be liberal. The soil is usually fertile and as large a crop of green stuff should be plowed under as is possible. For rye and vetch, sow one and a half to two bushels of rye, and twenty pounds of vetch. When rye alone is used sow three bushels per acre. The importance of having the land in the very best state of cultivation cannot be too strongly emphasized. The aim should be to have all green crops or manure thoroughly incorporated into the soil before the plants are set out. Cultivation before setting out time should be frequent and thorough in order to complete the foregoing and also to keep down weeds and to conserve moisture. The disc harrow is highly efficient at this season.

Manure and Fertilizers

Manure, unless it be applied in the fall previous to the crop, is best used with some preceding crop. Then it may safely be used quite freely. In growing early tomatoes nothing in the condition of the soil is desired that will check quick maturity and ripening of the fruit. Where a good rotation is followed and legumes plowed under there is generally sufficient available nitrogen to care for the needs of the plant as it grows, once the soil has become warm and the soil organisms become active in their work of releasing plant food.

Commercial fertilizers play a very important part in a successfully grown early tomato crop under a good system of soil management. Of the fertilizers used, those supplying phosphorus are by far the most important. Those recommended are acid phosphate sixteen per cent., steamed bone meal or bone flour (approx. 20% P_2O_5) and precipitate phosphate (26% P_2O_5). The last-mentioned of these is a comparatively new fertilizer, but is an excellent one for use with this crop on account of its high phosphatic content and its ready availability under our soil conditions. It is obtained as a by-product in the manufacture of baking powder.

Nitrogenous fertilizers are used only in a form which is immediately available to the plant, and their function should be mainly to assist the plant in getting established when first it is set out in the field and before the soil nitrates have been made available for its use. Nitrate of soda is chiefly used for this purpose when it is considered advisable or necessary.

Potash, applied as a commercial fertilizer, is usually not found necessary under good cultural conditions. Experiments, carried out with different growers of early tomatoes under varying soil conditions and methods of soil management, have proven that there is sufficient potash in the soil for the use of the tomato crop. This rule holds good under all but exceptional circumstances, according to the experience gained by the Vegetable Branch.

It is not possible to make any definite recommendations as to quantities of fertilizers to apply, suitable to meet all soil conditions. From what has been said previously, the grower should be able to judge fairly well what his own land needs. In applying phosphatic fertilizers from 500 pounds to 1,000 pounds of acid phosphate (16% P_2O_5), are used per acre. With the precipitate phosphate, which has a higher analysis, proportionately less is used.

For nitrate of soda, which contains approximately sixteen per cent. of available nitrogen, applications are made at the rate of 100 pounds to 150 pounds per acre.

For a mixed fertilizer, one bearing such an analysis as the following should give fairly good results; on light soils a 4-8-4, on medium loams a 3-12-4 or 2-12-2, and on clay loams a 2-12-0. Applications are made at the rate of from 500 pounds to 1,200 pounds per acre. The fertilizer may be broadcasted between the rows right after the plants are set out or applied just shortly before the field is marked out for planting. Cultivation should follow to work the fertilizer into the soil.

Varieties

Earliana is the standard early sort grown in Ontario. It is very early, is usually productive in the early season. The plant itself is a straggly growing type. The fruit of Earliana, especially that first set, is inclined to be rough. The flesh of the fruit is firm and there is a fairly large proportion of it, but the flavour of the fruit is generally considered only fair. The tomato has a heavy core running all the way through the fruit and it does not colour up uniformly.

Bonny Best, though grown sometimes as an early cropper, is a little later than Earliana. It is productive and makes a better looking plant than Earliana. The fruit is attractive, smooth and well-coloured, being more uniform in size and shape than the Earliana fruit and of better quality.

John Baer is a variety widely grown in Ontario as a second early or in some districts as an early cropper. In general qualities it is much similar to Bonny Best, being of very good quality, a solid-fleshed, coreless sort with few seeds. It is claimed to be an earlier ripening sort than Bonny Best, but under average conditions there is not much difference noticed.

Carter's Sunrise is an English variety used frequently where a staked crop is grown. It is a robust grower, is fairly early and is prolific. The fruit is of good shape and colour, but like most English varieties tends to run a little small for our markets during the summer season.

Seed

In securing seed the grower cannot exercise too much care. Price should not be the controlling factor providing the right sort of seed can be purchased. Great variations in strains exist within the same varieties and some are worth a great deal more than others. A good strain of good seed should have the following points to recommend it:

1. The seed should be large and plump with a good colour.
2. It should show a high percentage of germination.
3. It should be capable of producing plants which will bear early a large crop of smooth, uniform, high quality fruit of the variety named. Many of the reliable seedsmen have good strains of seed, and if the grower is not satisfied with what he can procure in this way he should save his own seed and conduct a seed plot. In this way it would be possible for him to develop a strain par-

ticularly adapted to his own conditions. The methods of carrying out a seed plot and of saving seed are given in the Appendix at the back of the Bulletin.

Growing the Plants

Greenhouses are used pretty generally throughout the early tomato growing districts of Ontario, though in some sections hotbeds are still in use and good plants may be produced by this method. However, under our climatic conditions and with the difficulty experienced in obtaining quantities of the proper sort of manure at the time needed for hotbed work, to say nothing about the extra care needed in operating the beds, early tomato growers are finding it pays to build a glass house. Many of the houses are used principally for this one crop and often are not fitted with an expensive heating system. Under most conditions, though, it should pay the owner of a good house to have it so constructed that he can operate it the year round if so desired.

The seed for the early crop is sown in flats in the greenhouse from February 21st, up until March 1st. The flats used are usually of a standard size, twelve inches by twenty-four inches and about two and a half inches deep, though any similar box is suitable. It is always advisable to have flats of the same size, however, for convenience in handling them and efficiency in the use of space in the house. Six small holes may be bored in the bottom of the flats or a space left between the inner edges of the bottom boards to assist in drainage.

The soil used in the flats is usually taken from a compost heap, prepared during the previous summer. This compost may be prepared by using straight sod, preferably of a good loam type, or by using alternate layers of sod and manure. Some growers favour straight sod compost with about one-third sand for use in their seed boxes, others use the sod-manure compost with about equal proportions of good sharp sand. One grower recommends the use of a phosphatic fertilizer such as phosphate flour when building the compost pile, sprinkling a layer of the fertilizer over each layer of sod as it is laid and using at the rate of about 100 pounds for each seven yards of sod.

When using the compost, the pile should be cut down straight from the top to the bottom and the soil well mixed and worked together.

For the seed boxes it is well to put a shallow layer of rough material, that which fails to pass through the sieve is suitable, on the bottom of the flat, to assist in the drainage. The soil for the top half of the box should be sifted, and the box filled to within about half or three-quarter inches from the top. Make sure that the corners have soil well firmed down in them, to prevent the water all running to these points after the flat is filled.

Shallow drills are made, in the soil after it has been levelled, by gently pressing with a marker. These drills can be made, ten in number, running the long way of the flat. Approximately 1,000 seeds per flat are sown and distributed uniformly. The seed is then covered to a depth of about one-sixteenth inch, by sifting sand over the surface of the seed bed. Following planting, the flat is thoroughly watered, using a fine sprinkler or, as is often the case, a piece of coarse burlap is laid over the surface and the water applied on it. Any further watering is done only when there is need for it. It is found to be a good practice to keep the flats covered with newspaper, loosely spread across the top, until the seed comes through, which is usually from eight to ten days after planting. The temperature of the house at this time should never go below sixty degrees F., and is better if kept around seventy degrees to seventy-five degrees F. A propagating house or section of the greenhouse that may be partitioned off will give an opportunity to control temperature conditions and will also result in a saving of fuel during this period.

Transplanting

Some growers transplant their young plants as many as three times, others follow the practice of only transplanting twice. Both methods give good results when well done and it depends upon the conditions under which the grower finds himself as to which plan he adopts.

The first transplanting is commenced after the first true leaf is out, usually about three weeks after the seed is sown. Up until this time the plant is carefully grown, to produce a stocky strong seedling. All the light possible is given after the seedlings are once up, water only when needed and the temperature is lowered somewhat with an increase in the ventilation being given.

The soil used is either straight compost or compost with a little sand mixed in. From fifty to fifty-five plants are set to the box. At this transplanting a marker, made of a board with little wooden pegs set at the required distances apart is very useful and, to one who is not practised to transplanting, is a splendid way of obtaining uniform planting distances. The little seedlings are handled and planted very carefully, being set down almost up to the seedling leaf.

Watering, after setting, is quite important. If the seedlings have been well watered previous to transplanting and the soil into which they are transplanted is in good condition as regards moisture, it is well to leave the watering of them till the following day when they will have recovered and straightened up. In the meantime, shade should be provided by spreading a newspaper above the flats. As in the case of the seed boxes further watering should be carried out only when the plants show that they must have it. This practice of watering on the following day after transplanting may be carried throughout with the future transplantings, also the recommendations as regards regular watering.

The temperature of the house is not allowed to go below fifty degrees F., and a day temperature of sixty, sixty-five or seventy degrees is advised. Ventilation should now be given as much as possible though direct drafts on the plants are to be avoided.

When three transplantings are made, the second starts when the plants begin to get a fair size in the flat, about two weeks after the first shift has been made. Eighteen to twenty-four plants per flat is the usual number. Starting with this transplanting the use of a handful of phosphate fertilizer in with the compost is advised, especially so if none has previously been used in the compost pile.

The last inside transplanting, the second or third as the case may be, takes place usually three to four weeks after the first. This may be made into four inch pots, but many commercial men use flats and eight plants are set in each flat. The flats are filled with straight compost usually, to which the phosphate fertilizer should be added as before. The soil should be in such a condition as to moisture that when pressed in the hand it will form a ball which breaks and crumbles in the fingers on releasing the pressure. Before each transplanting the flats of plants should be thoroughly soaked on the day previous to shifting.

At this shift the plants are set down almost to the bottom of the flat in order to develop as much root as possible. Regular watering is only given when the plants commence to droop and ventilation is increased to the fullest extent, including the use of the side ventilators when possible. The temperature at this period can safely go slightly below fifty degrees F., for soon the plants are to be set in the open field where they will be subject to such temperatures. Hardening off of the plants should be a gradual process throughout the whole period of their growth and at no time should the plants be allowed to become soft and leggy. During the last two weeks in the greenhouse or cold frame, the amount

of water which the plants are given must be reduced to a minimum if well-hardened plants are to be produced.

Planting into the Field

When the plant has reached the period in its development where it is ready to be set out into the field it should be a stocky, sturdy plant, well branched. The desirable colour for a plant of this type is hard to describe, but a blue-gray-green is about the nearest possible description. This is very different from the colour of a soft tissued plant whose colour is much more of a vivid or brilliant green.

Most growers like to have the first cluster of bloom set before the plant is transplanted outdoors. Some, even, prefer to have the second cluster set as well and perhaps the third showing bud.

Spraying of the early tomato is not much practised except that done while the plants are still in the greenhouse. Bordeaux in both the spray and dust forms may be used. The applications tend to control such diseases as leaf spot from getting started while the plants are inside and the bordeaux has a further stimulating and invigorating effect on the plant itself.

The proper type of plant for setting outdoors for an early crop.

The tomato plants should not be set out until danger of frost is past. This date varies with different districts, but is usually considered constant enough within a district that the same planting date is followed year after year unless exceptional circumstances interfere. At Leamington, plants are set out as early as May 15th in some years, and a season such as we had in Ontario in 1923, held the bulk of the planting back until about May 22nd or after. At Blenheim, the planting date is considered to be May 20th. By the 24th of May early tomatoes should ordinarily be set in the fields in all the early districts.

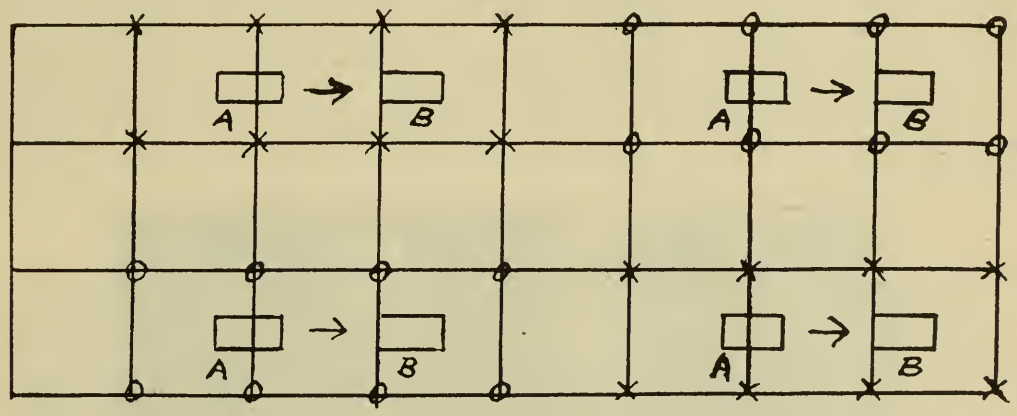
The practice of "blocking" is frequently done about one week or ten days before the plants are set out. This consists in cutting into eight equal squares the soil and roots which support the eight plants within a flat. This is to cause the formation of new rootlets and thus help to prevent the plant from getting a setback when first set out.

Thoroughly soaking the flat on the day previous to setting out should be practised, or if it is very hot weather the flats could also be watered in the

morning of the day the transplanting is done. Planting distances vary somewhat, though four feet by four feet, and four feet by five feet are probably those most commonly used. One successful grower advocates three feet eight inches by five feet as giving him a distance more adapted to the efficient use of a one-horse cultivator.

The plants are set on the square and are cultivated both ways. Different methods of marking out the field are in use. Sometimes furrows are plowed out and a marker run the opposite way, but one of the most satisfactory methods is to mark the field with a four-runner marker and then cross-mark it. At the intersections a man with a shovel can dig holes fast enough to keep three and perhaps four men planting.

By following the plan here represented when placing the flats in the field a lot of time may be saved for those planting:



A—the flat containing eight plants as set off from the waggon. Four plants are planted from this position, then the flat is pulled on to B, from where the remaining four plants can be set out.

As much soil is left adhering to the roots as is possible and the plant is set down somewhat deeper than it was growing. The soil should be well firmed around the roots, and as the planter passes on to the next plant he stirs some loose soil over the top soil around the root of the plant, using his hand for this operation.

Following shortly after planting, light applications of nitrate of soda are often made to the plants. Some growers also apply a mixture of nitrate and a readily available phosphatic fertilizer in the rows before the first cultivation is given.

Cultivation

Cultivation should follow directly after the plants are all set out and should be continued as often as is possible up until the time when injury would be done to the roots or tops of the plants. Cultivating twice a week is a frequent practice and once a week at least should be the minimum amount. The first cultivation should be deep, and shallower cultivation should follow with each successive time. Some hoeing is also necessary, the number of times depending upon the needs of the crop. Clean fields with a good dust mulch maintained at all times should be the aim.

Picking and Packing

Time of picking.—There are three stages at which tomatoes are picked for shipping purposes—mature-green, pink and ripe.

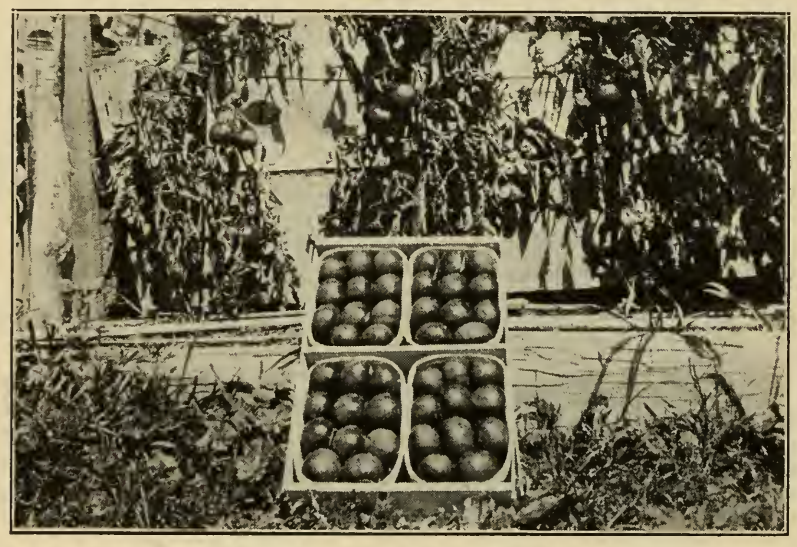
The mature-green should not be picked under our conditions as there is a chance that they will not ripen in transit and besides they do not carry as well

or any better than the pink grade. The pinks are picked just when faint tinges of pink are showing on the tomato. This is the stage at which all the fruit should be picked if for the distant markets. For local markets the red fruit has its place, and the degree of ripeness depends on how near the market is. Only sound, firm fruit should be picked at any time.

Picking.—When the crop is at its height, pickings are made every day or every other day. Great care should be exercised both in pulling the fruit from the vine and in handling it up to its final packing. With the vine held firmly, fruit at any stage of ripeness can be easily pulled by giving it a half turn and a gentle pull.

For picking into, eleven quart baskets are widely used, though twelve quart woven baskets are perhaps more useful. Crates or boxes are sometimes used to carry the fruit from the field to the packing shed. However, the less handling and knocking about the fruit gets the better for its condition, so where possible it is often advisable to remove the original container right to the packing shed.

Packing and packages.—The tomatoes are divided into two grades and the culls. For firsts, good-sized to medium, smooth, sound, uniformly coloured and sized fruit should be used. The seconds should be made up of fruit graded as



Each basket contains two layers and holds approximately five pounds of fruit.

well as possible to size, sound (healed cracks are permitted) good colour and not excessively rough. The various degrees of ripeness of the fruit act as a basis for grading so that uniformly ripe baskets are packed and shipped accordingly.

Eleven quart climax baskets are used almost exclusively for packing this crop in. A basket will hold three layers of medium sized fruit and weighs in the neighbourhood of fifteen pounds. The top row should be only just level with the top of the basket and should present a neat attractive appearance when it arrives at its destination. Flat, slatted basket covers are used to put over the fruit.

The four basket, twenty-pound box is coming into use in a small way in some sections where early tomatoes are grown. This package is admirably suited to the packing of a high grade of choice, fancy fruit. It is a pack that should be encouraged by the trade and one which should command a higher price than the basket pack. Well-packed fruit in this type of container arrives at distant markets in excellent condition.

Staked Tomato Culture

In some of the tomato growing sections the practice of pruning the tomato plants to a single stem and training the plant to a support is followed by some growers. This method is carried out on an extensive scale chiefly in the Burlington and Niagara districts, though it is frequently practised by gardeners elsewhere, wherever tomatoes are grown.

Some advantages for pruning and training offered are: 1.—Earlier ripening. 2. Larger fruits. 3. Less disease injury. 4. Cleaner fruit. 5. More convenient harvesting.

Some disadvantages suggested are: 1. Greater amount of labour and expense. 2. Less total yield per plant. 3. Greater loss from blossom end rot. 4. More sun scald on the fruit. 5. Greater amount of cracking.

Different ways of carrying out the planting for the staked crop are in use. Single rows of plants set eighteen inches apart in the row, and the rows three and a half feet to four feet apart are planted. Another method, and one often found in use amongst large growers, is to set out two rows of plants eighteen inches apart in the rows, and the rows two feet apart with a four foot width on either side.

Stakes of wood one inch by one inch, or one and a quarter inches by one and a quarter inches square are often used. These are usually five feet to six

Tomato plants trained to iron rods supported by wires.

feet long, and are driven into the ground to a depth of twelve inches to fifteen inches, and a few inches away from the plant. The stakes should be driven soon after the plants are set out and before injury to the roots is likely to result. Iron rods may be used if obtainable and sometimes laths supported by two or three tightly stretched and securely fastened wires are used. Bamboo poles also make good supports.

Raffia is one of the best materials for tying the plant to the stake and this operation should commence soon after the plants are set out. The tying is continued as the plant grows, probably every ten days until about four tyings have been made. Plenty of room would be left in the loop around the stem to allow for development and growth. A good plan is to form the loop just below a leaf stem.

Pruning tomatoes to a single stem consists in cutting or pinching out all branches as they appear from about the base of the plant and in the axils of the leaves. The removal of the side shoots should take place regularly, at least once a week, during the main growing season. It may be desirable, for

the sake of earliness and after enough clusters of fruit have set, to pinch out the central leader of the plant.

Soil preparation must be very thorough for this crop and the land must be in a high state of fertility with a great abundance of available plant food. Commercial fertilizer is used with good results in much the same way as recommended for the prostrate method of cropping. The phosphatic fertilizer should be applied in the row or rows where the plants are to be set and well worked into the soil previous to setting the plants out. Some growers get successful results from as many as three light applications of nitrate of soda about the plants, starting right after the transplanting into the field. The practice of mulching with rotted manure around the plants is a popular one, cultivation in the wide rows being maintained as long as possible without danger of injury to the plant's roots.

Of the varieties used for staking, Bonny Best, Ideal, John Baer and, for some markets, Carter's Sunrise all give good results. "Ideal" seems to be a good variety for this purpose, while "Bonny Best" in the opinion of many growers is scaled down a little on account of its susceptibility to blossom end rot. "Carter's Sunrise" is a prolific bearer, but the fruit is small and only suited to special markets.

Plants for the canning factory. Crop grown in a flat, ready for transplanting.

THE LATE TOMATO CROP

The Tomato Canning Industry in Ontario

The past thirty-five years have seen the development within Ontario of the tomato canning industry from a small beginning to its present flourishing condition. The industry now represents an important crop produced throughout many sections of the Province.

The following figures, based on a 1922 report from a survey of the canning industry made by the Dominion Bureau of Statistics, are of interest. Ontario had sixty-seven per cent. of the operating plants and produced seventy-one per cent. of the total output of canned fruits and vegetables within the Dominion. There were seventy-nine factories in Ontario in 1922 canning fruits and vegetables, and of this number it is estimated that approximately seventy are fitted for canning tomatoes.

The pack in Ontario is placed at from 900,000 to 1,000,000 cases, which has a value, in round figures, of $3,000,000. The 1922 report indicates that

Scene at a tomato canning factory in Western Ontario.

there is no Canadian export trade in canned tomatoes, but that we do import a small quantity from Italy and the United States.

The estimated acreage grown to this crop is placed at 10,000 acres more or less. It is of interest to note that during the past ten years the average production per acre as in relation to the pack has increased approximately twenty-five per cent. according to information supplied. There would appear to be every reason to look for a steady development of this important industry within Ontario in the future years, especially so if it is possible to develop an export trade.

The districts in Ontario where the crop is grown may be divided into four:

1. Prince Edward County, where existing conditions are peculiarly its own.
2. Eastern Ontario (excluding Prince Edward County). This district would include the territory along the Lake Ontario shore line from Napanee to Oshawa.
3. The Niagara Peninsula from Hamilton on through the district southward to Niagara Falls, including the southern part of Norfolk County.

4. Southwestern Ontario. This district would be mainly that south of an imaginary line drawn between London and Sarnia.

This grouping tends to show that the crop is grown almost entirely within our fruit and specialized crop belts. Mixed farming, however, predominates within these districts and it is by this class of farmer that a large percentage of the crop is grown.

Soils

In Ontario, late crop tomatoes are grown on a wide range of soils and yields and crop results are quite as variable. It is a difficult matter to say just what is the best soil type. As a guide, however, the grower is safe in selecting any good fertile, well-drained soil and avoiding run-down, wet soils in poor physical condition.

The soil types preferred are rich, sandy loams full of humus and overlying a moisture-retaining sub-soil or good fertile clay loams in good tilth and well-drained. It is usually considered that the heavier type of land gives a more solid and firmer fruit, therefore one of somewhat better quality for canning. However, the treatment of the land and the handling of the crop may make a great deal of difference both in yield and quality of fruit on all types of soil.

Drainage is necessary to ensure the best crop results and if not naturally existing should be artificially provided for in some form. The plants, especially when young, will not stand "wet feet" and any land on which there is liable to be standing water at times is not suited to the growing of this crop.

Preparation of the Land

No crop when put into a poorly-prepared seed or plant bed can be expected to do its best. The tomato plant demands the greatest attention to the preparation of the land into which it is to be set out.

For sod or clay lands fall plowing is recommended and this is to be followed in the spring with a second plowing or, under any conditions, frequent discings until the plants are ready for the field. Loam and sandy loam soils can be left till spring when they should be plowed fairly early and kept well worked till needed by the crop.

Just before the plants are set out the surface of the field should be levelled and the top three inches of soil put into a fine condition. Usually the drag harrows are sufficient for this purpose if used to cross and re-cross the field. A planker is sometimes necessary in a field inclined to be lumpy. This useful implement can be made by any handy man. It requires the use of half a dozen two-inch planks, bolted together by the use of good solid cleats. The planks are laid so that from the front one each following plank rests its forward edge on the one just ahead of it. This arrangement makes it so that all lumps over which the planker passes are hit by each one of the six planks in turn and thus pulverized.

Crop Rotation—Manure—Fertilizers

The best way to handle most farm crops is to grow them in rotation. This holds very true with the tomato crop, both from the standpoint of soil fertility demands and of disease control.

It is a general practise with late tomato growers to plow down one of the clovers for the tomato crop. Usually this is possible where the grower practises mixed farming. The crop following tomatoes should be one which will take full advantage of the remaining fertility in the land. Sometimes it may be possible to follow the crop with one of fall wheat. It is a good practise to sow a cover

Chalk's Jewel Tomato.

crop in among the tomatoes late in the season before the last fruit is harvested. Rye is the only one which can be generally recommended.

The tomato plant is equipped with roots which are comparatively poor foragers and so must have plenty of available food in the soil where it grows. In addition to plowing under a cover crop both manure and commercial fertilizers are used.

Manure, when applied, should be plowed under in the fall unless it is planned to use very well-rotted manure in the spring. Whenever it is used, however, the manure should be well worked into the soil. Fresh manure used in the spring tends to make the crop too late in maturing on account of the nitrogen causing too much leaf and stem growth over too long a period. On average good land where clover is plowed under and some commercial fertilizer used, manure is applied at ten to twelve tons per acre.

Commercial fertilizers should not be depended upon alone to produce a good crop. Their place in the growing of tomatoes should be as a supplement to treatment as suggested previously. Through their use, to bring about a balanced condition in the fertility of the soil should be the aim.

From the results of experiments carried out during the past few years under the direction of the Vegetable Specialist and covering conditions found in all of the commercial vegetable districts in Ontario the following results were found:

1. That the returns from applying potash to rich soils for the tomato crop did not appear to justify its use at the high prices charged for potash fertilizers.

2. Fertilizers such as acid phosphate (sixteen per cent.), steamed bone meal or precipitate phosphate (twenty-six per cent.), supplying an abundance of phosphorus, could be profitably applied under all conditions.

3. Nitrogen in a readily available form, as it is in nitrate of soda, is often of great benefit in producing a paying crop of tomatoes. Where such a nitrogenous fertilizer is used its purpose is to assist the newly set out plant in making a vigorous start and to assist in overcoming any tendency toward a check in growth incident to the change into field conditions. Where clover or manure or both are used no other form of nitrogen is usually needed.

When a nitrogen-yielding fertilizer is used alone it is usually applied just after the plant is set out. From 100 to 150 pounds per acre is the usual amount of nitrate of soda used and a small portion of this is placed in a circle around each plant, afterwards being worked into the soil. Care must be taken in applying all fertilizers that they do not come in direct contact with any portion of the plant or else injury is liable to take place. The fertilizer should not be applied directly above the roots but spread from six inches to one foot away.

The problem of the use and application of commercial fertilizers is one which is a local problem and can be properly solved only by the individual grower studying his own conditions and needs. A few general suggestions may be useful in aiding the grower to meet his peculiar conditions.

From reports covering Eastern Ontario districts where the land has been enriched through clover being plowed under and a liberal use of manure, the application of 400 to 500 pounds of sixteen per cent. acid phosphate per acre seems to be generally accepted as the best practice.

On light soils which are poor a complete fertilizer such as 4-8-4 or a 2-12-2 might be used at the rate of 600 to 1,200 pounds per acre. For soils of medium fertility a 3-12-0 or 5-12-0 fertilizer can be profitably applied at from 300 to 500 pounds per acre, and for rich soils where manure or legumes have been used acid phosphate (sixteen per cent.) at 300 to 500 pounds per acre is recommended. Precipitate phosphate is also recommended as a form in which to apply phos-

phorus; it contains about twenty-six per cent. available phosphorus (P_2O_5) and is readily made use of by the plant. Quantities applied will necessarily be less than when using acid phosphate to get the same results. Under practically all soil conditions in Ontario, where commercial crops of tomatoes are grown, we have found that the use of a readily available nitrogen fertilizer, if a nitrogen yielding fertilizer is used at all, and of a phosphate fertilizer, such as acid phosphate (sixteen per cent.), is all that is necessary for best results in the use of commercial fertilizers.

In applying complete or phosphate fertilizers to the land they may be either broadcasted at the time of the last cultivation preferably or applied in the rows soon after planting. For large amounts the broadcasting is probably the better method, while for the amounts of 500 pounds and less, spreading in the row does not require much labour and would no doubt be a somewhat more suitable method. In some districts the practice is in use by some of the best growers of broadcasting part of the fertilizer and of drilling the remainder into rows, following these rows later when setting out the plants. This practice is one worthy of greater use.

Seed

Good seed is a very important factor in the production of a successful tomato crop. By the term good seed we mean the capacity of the seed to germinate well and to produce strong, vigorous plants. The term also includes the idea that the seed is from a variety or strain suited to the local conditions under which it is to be grown and one which has been developed so as to meet the following demands: early maturity, high yield, uniformity and quality of fruit produced.

The difference in cost between such seed and nondescript stuff should not be considered. When the grower considers that about two ounces of good seed will produce enough plants to set an acre or more and offsets the first cost of the seed against his final returns from both kinds he never should use unproven seed. With many kinds of seed, including tomatoes, it is good business to purchase a year's supply ahead and to try out a sample of it under field conditions. By this method one can see whether the seed is producing what is expected of it and if it fails no serious loss is suffered.

A simple germination test may be made by counting out a definite number of seeds and placing them between two sheets of moistened blotting paper. The blotting paper should be kept moist and in a warm temperature. For a good sample, at least eighty per cent. of the seed should germinate within eight days.

Seed plots for the grower of late crop tomatoes are to be recommended where the supply of seed available to him does not produce plants which give the results he demands.

The method of conducting a seed plot is discussed in the Appendix at the back of the Bulletin.

In Ontario the canners themselves usually prefer to distribute seed to their contracted growers. This seed is grown by themselves at special seed farms or obtained, in the case of some of the smaller firms, from sources where the seed produced is calculated to meet the highest demands for a suitable canning factory tomato.

This system has much to commend it. The seed is grown from only those varieties selected as being best suited to the different districts. It is produced under competent supervision for the desired factors which go to make up a good strain of seed for a factory crop. If the proper objective is taken, the

work should result in mutual benefit to both parties concerned, in that a tomato more suited to the needs of the canning trade and yet a heavier yielding, more disease-resistant cropper should be developed.

Varieties

In Ontario the varieties used for the main canning crop are limited largely to three—Bonny Best, John Baer, and Chalk's Early Jewel.

Other varieties are constantly being tried out, but none seem to be of sufficient merit to replace those mentioned. Stone and Baltimore, two sorts largely used by the canning trade in the United States, as yet have not proved suitable for use in Ontario, both being later in maturing than those now grown.

Growing the Plants

The plants for the canning crop are produced in different districts under somewhat different systems. The canners may grow the plants at a central farm where greenhouse and cold frame space is available; local factories may grow sufficient plants to supply their own contracted growers or they may arrange with commercial greenhouse men in the district to supply a part or all of their needs; then the farmer may grow his own supply or, as is done in some cases, he may have his plants started for him by a greenhouse man and then transplant them himself into cold frames or open beds.

Where the canning company operates a central plant, as is done in Prince Edward County, the plants are turned out to the growers, ready for setting into the field, in flats containing approximately one hundred well-hardened, stocky plants six to eight inches tall.

Commercial growers who produce once-transplanted plants ready for setting out are able to sell them to the growers at $3.50 to $5.00 per thousand. Many growers find that where they can secure good plants this is a better plan for them to follow than that of growing their own plants.

Where it is possible for a farmer to get his plants started for him by a greenhouse man it allows him to be independent of the use of a hotbed, as he can transplant direct into cold frames. In some cases the cold frames may require to be banked around with manure if the weather should be cold and backward. However, where a grower either through choice or necessity grows his own plants from seed, in the majority of cases a hotbed is necessary. The principles of hotbed construction, as well as that of cold frames, is given in the Appendix at the back of the Bulletin.

Operation of the Hotbed

Plants which have been well grown should be ready for setting in the field about seven weeks after the seed is planted. From the last week in March on into April is the time when the seed is sown and the best date must be arrived at by the grower himself.

After the seed bed has been thoroughly prepared and the temperature is normal within the bed, the seed should be sown in shallow drills about four inches apart and with six or seven seeds to the inch of drill. Afterwards, the seed is covered lightly with fine soil or sand to a depth of about one-quarter inch. A thorough watering should follow, sprinkling the bed uniformly with a fine spray. Further watering should be done only when needed, when dryness commences to be evident. Excessive watering is bad at any time and after the seedlings are up is liable to cause great loss through damping-off. Too much water tends, also, to produce a soft-tissued plant which is undesirable.

The temperature in the seed bed should be fairly warm at first, with no more than a ten-degree variation between night and day temperatures. A day temperature of seventy-five to eighty-five degrees Fahrenheit, until the young plants break through, is kept and then lowered about five degrees. After about ten days a day temperature of sixty-five to seventy degrees Fahrenheit will be sufficient. Ventilation should commence as soon as possible, and be increased gradually.

About two weeks, or perhaps a little longer, from the time the seed was sown, depending upon conditions under which the plants have been grown, the young seedlings should be ready to transplant into cold frames. The time to transplant a young tomato seedling is after the first true leaf has developed, before lifting the seedlings water the bed well so that the tiny roots will not be pulled off and so that soil may adhere to the root system.

There are different devices to aid in transplanting; some sort of marker which will make the holes at the required distance apart is often helpful. The plants may be set from two inches to four inches apart, the latter distance is advisable where the best plants are wanted. Set the plants in a little deeper than they were in the seed bed and have them straight and firmly set. Water the plants soon after they are set out and when the bed is all planted provide shade for a day or two until the plants have recovered from the shock of transplanting. However, do not do this to the sacrifice of ventilation. Newspapers spread above the plants are as good as anything. From now on the grower's object is to maintain steady growth and to produce a stocky, well-hardened plant for setting into the field. To properly harden the plants, the cover of the frame will be left off most of the time toward the last of the period that the plants are in it.

Transplanting to the Field

The removal of the plants to the field usually takes place from about the last week of May to June 10th. The canners prefer to have the crop come in from mid to late August, through September and early October, so that the plants should be grown and set out to mature their fruit for this season. The quality of the fruit is better at this time than when the weather is extremely hot.

The land on which the crop is to be grown should now be in the best possible state of tillage. If it is possible, a dull, cloudy, windless or damp day should be chosen for setting out the plants. Transplanting on bright, hot days is often very disastrous to the plants, especially so if they have not been well hardened previously. Early morning or in the evening of hot, bright days would be a better time to transplant than during the mid-day.

Planting distances vary from three and one-half by three and one-half feet, four by four feet, four by five feet to five by five feet; four by four feet seems to be the one in most general use and requires that approximately 3,000 plants per acre be provided to take care of all requirements, including losses and poor plants. It is found that if plants are set three feet eight inches by four feet it is a somewhat better width for efficient cultivating with the ordinary horse cultivator. It is always advisable to set the plants so that a cultivator may be run both ways of the field.

Depth of planting varies with the plants. In any case, the plants should be set deeper than they were in the seed bed. Usually from four to six inches is sufficient for stocky plants, while leggy ones may require to be set double that depth or else spread along the furrow. New roots grow out from the portion of the stem in contact with the soil.

Transplanting machines are used to set out the late tomato plants in some

sections, but hand planting is still widely used. There are certain advantages in the use of a machine, especially where the acreage is large. The machine enables the grower to set his plants much faster. It provides for an application of water in the furrow and it leaves the soil around the plant and in the rows in a less packed and looser condition than does the other method. To offset these advantages the first cost of the machine is high and unless the ground is in good condition and careful operators run the transplanter a poorer job is likely to result than through the hand method. In some sections home-made machines are used. Frequently a machine is owned jointly by a group of neighbours or in tobacco-growing sections it is often possible to rent a machine.

When the plants are set out by hand different methods may be used for marking the field and preparing the hole. One of these is by plowing furrows both ways across the field at the required distances and setting the plants at

A well cared for field yields a paying crop.

the intersections. Another way, and probably one of the best, is to make a marker with four runners set at the correct distance apart and go both ways across the field with it. One man with a shovel or spade can then make holes at the intersections fast enough to keep at least three others busy planting. Any way which can be efficiently used and which provides a suitable place in which the plant can be firmly set and planted is suitable.

Cultivation

Cultivation of the crop should start immediately after the plants are all set out in the field. At first it should be fairly deep and may safely extend in fairly close to the plants. Some growers try to cultivate at the first cultivation so as to throw a little soil in toward the plant.

Succeeding cultivations should be made each week or ten days at least. It is always good practice to cultivate after every rain so as to keep a dust mulch constantly on the surface of the ground. A spike-tooth cultivator is usually best for these later cultivations.

The time to discontinue cultivation is when it is found by observation that the cultivator teeth are injuring the root systems of the plants. From then on further cultivation will do more harm than it will do good.

A survey made on tomato growing in the Niagara Peninsula by the Department of Farm Management of the Ontario Agricultural College showed that the men who made the greatest profits all plowed their land twice and cultivated the crop regularly and often.

Harvesting

Under average conditions the grower may look to make his first picking about eighty days after the plants have been transplanted to the field. This is usually on into the month of August and the season usually lasts until frost kills the vines.

Half-bushel wicker baskets are probably the most serviceable things to pick into. The factories supply bushel crates or hampers for hauling the crop from the field to the factory. Some factories use a five-eighth bushel hamper with sloping sides. This receptacle carries the fruit in very good condition and can be loaded on the waggons in tiers with little injury to the tomatoes.

In gathering the fruit, it should be red ripe but not soft or leaky. Canners demand a high grade, uniformly ripe product of fair size. When the fruit is pulled from the vines it should be done carefully so as not to subject the vine to injury. Careless picking which pulls the vines about may cause a considerable reduction in yield.

Yields and Profits

The question of yields and profits is a difficult one to deal with as both vary so greatly. Figures from records taken from thirty-seven farms in Niagara District in 1923 show a variation in yields of from seventy bushels per acre to as high as 800 bushels per acre. This is not exceptional and occurs in other districts as well.

Two hundred bushels to 225 bushels per acre as an average for any one district would be setting a high average yield. Delaware Bulletin No. 101, published on the basis of pre-war conditions, stated from its findings that it was necessary to produce a crop of over 4.8 tons per acre before profits began to be realized. On an eight-ton crop, taking the above costs, a net profit of $25.60 per acre was realized.

The 1920 survey made by the Department of Farm Management, Ontario Agricultural College, among tomato growers in the Niagara District, showed that only a very few were making a profit on their crop. The costs of production included all contributing items as rent of land, taxes, interest, previous fertilizers used, all labour put on the crop and all the other costs. This survey was made in a period of unusual economic conditions and in the Niagara Peninsula where land values are extremely high and where other overhead charges are greater than in most of our mixed farming districts.

The value here of the foregoing lies in the fact that it points out that the grower who expects to make a reasonable profit on his crop must be able to get a yield somewhat above the average. He must also handle his crop from the time he starts to grow it in the most efficient manner and so cut down his costs of production as much as is possible.

Many good farmers grow tomatoes year after year for the factories, and though they do not keep cost accounts, yet they know that their tomato crops are paying them a better profit, one year with another, than some of the other farm crops they might grow. A grower's own peculiar circumstances and conditions decide whether he can profitably grow this crop or not.

APPENDIX

COMMON DISEASES OF THE TOMATO

Leaf Spot or Septoria Blight (*Septoria lycopersici*, Speg.)

This is the commonest disease of tomatoes grown in the open in Ontario. It affects the leaves and sometimes also the stems and fruits of tomatoes and is very hard to control.

Symptoms.—Small greyish brown, angular spots, containing minute black specks, appear upon the leaves and stems. The lower leaves are first affected and the disease spreads upwards, often almost completely destroying the foliage of the plants. The organism which causes the disease is carried over the winter in the soil of field, greenhouse or hotbed.

Prevention.—Spray with Bordeaux mixture (four pounds bluestone, eight pounds hydrated lime and forty gallons of water) or with Bordeaux resin fish-oil spray. Begin spraying soon after transplanting and continue at ten-day intervals until five or six applications have been given. With small patches of tomatoes it is often advisable to stake and tie up the plants for greater convenience in spraying. The diseased tops should be raked up and burned and, if practicable, a rotation of crops should be followed.

Leaf Mould or Leaf Blotch (*Cladosporium fulvum*, Cke.)

This disease is frequently met with in greenhouse crops of tomatoes and occurs to a lesser degree in the field.

Symptoms.—The leaves, especially the lower surface, become covered by an olive-brown mouldy or felt-like fungus growth. Affected leaves turn yellow or brown and in severe cases may shrivel and die.

Prevention.—Proper ventilation of the forcing house is the best preventive. The disease will not develop if there is a good circulation of air so that the moisture does not condense upon the leaves. It is also advisable to endeavour to water the plants so as to wet the leaves as little as possible. The watering of the plants is best done in the mornings of bright sunny days. Spraying with Bordeaux mixture at intervals of ten days or two weeks will hold the disease in check but is seldom necessary if the greenhouse is well ventilated and the plants properly watered.

Fusarium Wilt of Tomatoes (*Fusarium lycopersici*, Sacc.)

This disease is sometimes met with in greenhouses in Ontario.

Symptoms.—Leaves of affected plants slowly wilt, turn yellow and die. The lower leaves are first affected. If the stem of a wilted plant is cut across the woody fibres are seen to be brown or discoloured.

Prevention.—The fungus which causes this disease lives over in the soil often for several years. Sterilization of the soil of the seed bed and greenhouse with steam or formalin is necessary, therefore, in order to control this disease. Renewal of the soil will accomplish the same results.

Some resistant varieties have been developed in the United States and it is possible that they may be used to advantage in this country if this disease becomes serious.

Disinfection of the seed with corrosive sublimate is also recommended but has not as yet been tried out in Ontario.

Winter Blight or Streak of Tomatoes

This is one of the most troublesome diseases of greenhouse tomatoes in Ontario. The cause of this disease is not known, but excessive amounts of nitrogen appear to markedly aggravate the trouble. This streak is frequently associated with mosaic.

Symptoms.—The first indications of winter blight or streak are a curling and twisting of the upper leaves and younger portions of the stems. Brown sunken streaks appear in the young vigorous growing stems, and these increase in width until the whole upper part of the stem may appear brown. At first the browning seems to be on the surface only, but soon becomes deeper seated and in bad cases involves the woody ring. At the same time that these streaks appear on the stem, brown angular spots appear on the leaves between the veins, and these brown spots may increase in size until the whole leaf is involved. Fruit sets very sparingly, often not setting at all on the first two or three trusses. The fruits that do set are commonly scabby, deformed and of poor flavour and colour. Large, soft, sappy, vigorous growing plants are those most subject to this trouble.

Prevention.—The Department of Botany of the O.A.C. has been carrying on investigations concerning the control of this disease and, as a result of these investigations, the following recommendations are made: Avoid the use of too much manure or nitrogen-containing fertilizers, such as ammonia and sodium nitrate. Add acid phosphate or bone flour three ounces per plant and potassium sulphate one-quarter ounce per plant, either before transplanting or just after the blossoms appear. Avoid over-watering and then allowing the plants to become too dry. Keep the plants growing evenly by keeping the temperature uniform and watering at frequent intervals, but not too much at one time. Do not attempt to force plants that have been checked.

Blossom End Rot of Tomatoes

This is generally considered to be one of the so-called physiological diseases, not being due to any organism but to some condition within the plant itself, probably induced by its environment. Improper fertilizers and irregularities in the water supply appear to be important factors in causing this trouble.

Symptoms.—The trouble appears usually when the first fruits are about half grown or a little later. Slightly sunken water-soaked areas are seen near the tip of the fruit. These are at first lead-colour or brownish, but soon become dark brown or black in colour and of a hard leathery texture. Various fungi and bacteria may gain entrance through these injured spots and cause rot which may destroy the whole fruit.

Prevention.—Avoid over-forcing the plants, especially in the early stages of their development. Excessive amounts of organic fertilizers appear to have a marked effect in increasing this trouble. The water supply of tomatoes grown under glass should be even and regular. Some tomato growers claim to reduce the amount of this trouble by mulching their plants. Others consider that repeated good cultivation to conserve the moisture supply is the most effective preventive measure.

Tomato Mosaic

This is a disease of unknown cause frequently seen in Ontario both in the field and under glass. It is known to be transmitted from plant to plant by plant lice or other sucking insects and by workmen pruning and tying plants in the greenhouse or field.

Symptoms.—The leaves of affected plants may be mottled with light green or yellow or they may be dwarfed and have a peculiar fern-like appearance. Sometimes the leaflets are so narrow and slender as to appear almost threadlike. This form of disease is referred to as the shoe-string type.

Prevention.—Never use tomato plants from seed beds in which mosaic has developed. Destroy all weeds belonging to the potato family growing in or around the greenhouse, such as horse nettle, ground cherry and black night-shade. These weeds are known to harbour tomato mosaic. So far as possible control aphids by spraying or fumigation. In starting a new lot of tomato plants do not put them near any old plants which have shown symptoms of mosaic.

INSECTS ATTACKING TOMATOES

Cutworms

These are stout, smooth caterpillars about one and one-half inches long when full grown. There are several common species. These differ considerably in colour, some being brown, others nearly white, others nearly black. Some have conspicuous stripes or other markings on the upper surface, others have not, but are of a nearly uniform colour throughout. The adults are stout, usually brownish moths which fly around in the evening and at night and often come to lights. The eggs of most species are laid in weedy places. Most kinds of cutworms pass the winter as partly grown larvae in the soil and commence feeding as soon as vegetation begins in spring. Feeding is nearly all done at night. During the day the cutworms hide either just under the surface of the soil or under any rubbish which will conceal them. When they are full grown they pupate in the soil and in a couple of weeks transform into moths. Some species have only one brood a year, others two. As the name "cutworm" suggests, they have the habit of cutting plants off, usually just at the ground. Some species, however, climb the plants and feed on the foliage without cutting off the stem. A couple of common species feed underground and destroy plants by eating the roots. These species do not often attack tomatoes. Cutworm injury is most common in spring when large numbers of freshly set out plants are often cut off and destroyed. Injury, however, is not limited to the spring, for some years there are serious outbreaks in July and also in late August and September. In these later attacks the cutworms very commonly eat into the fruit and thus do much damage.

Control.—The best remedy for these pests is to use a poison bran bait for which the common formula is twenty-five pounds bran, one pound Paris green or white arsenic or the equivalent of either of these in the form of liquid sodium arsenite (usually about one-half pint), one-half gallon cheap molasses and two gallons or a little more of water. If the Paris green or white arsenic is used mix this and the bran dry. Pour the molasses on the water, stir and then pour the liquid on the poisoned bran and mix thoroughly until every part is wet and crumbly so that it will spread easily. If liquid sodium arsenite is used pour it into the water and molasses, stir and then pour upon the bran and mix as above. Sometimes the addition of a couple of lemons or oranges run through a meat chopper helps to make the mixture more attractive.

Apply the bait in the evening about dusk by scattering it thinly by hand over the infested plot or by dropping a small quantity (one-half teaspoonful) alongside each plant. If it is known ahead of time or is strongly suspected that cutworms are in the soil, injury can be averted by preparing the ground well

for planting and a day or two before setting out the plants scattering the bait in the evening over the fields. By this method the cutworms will be enticed to feed and be destroyed before the plants are set out.

As the moths commonly lay eggs in weedy places the freer the ground is kept from weeds, especially after the first of August, the less danger there will be of cutworms. Fields that are not in crop after July should be plowed at once and kept clean the rest of the season by occasional cultivation.

Tomato Worm (*Phlegethontius quinquemaculata*)

This is a large, stout, green worm with a horn at the rear end and V-shaped white markings on the sides. Full grown caterpillars are three inches or more in length. When abundant—which, fortunately, is not very often—they can quickly strip the plants of all their foliage. The adults are beautiful, large, grayish moths with spindle-shaped bodies and long, narrow wings. The wing expanse is about four inches. As the adults fly in the evening or at night, they are not often seen. The pupa is reddish brown, one and one-half to two inches long, and unlike most pupae has a handle-like structure at one end. The pupal stage is passed in the soil. The insect winters in this stage. The moths appear in late spring and early summer and lay their eggs on the leaves of the tomatoes. There is ordinarily only one brood of the tomato worm a year.

Control.—Picking off the worms by hand and destroying them is the common method, but they can also be killed by spraying with arsenate of lead at the strength of two pounds of the powder to forty gallons of water. Apply this as soon as it is seen that there are sufficient worms present to justify spraying.

Potato Flea Beetle (*Epitrix cucumeris*)

This is a tiny, black beetle scarcely as large as the head of a pin. It feeds upon the foliage, especially of the young plants soon after they are set out, and by eating numerous small holes in the leaves weakens the plants greatly. Sometimes the beetles get into the hotbeds or greenhouses and damage the plants even before they are set out. Almost all of the injury is done in the early part of the season. The adults winter under leaves and rubbish and come out in April and May and begin their feeding as described above. They lay their eggs in the ground close to the plants. The larvae, which are white, slender and worm-like, but with a distinct brown head and with short, stout legs, feed in the soil on the roots of tomatoes and potatoes and some other plants. The larvae seldom do any damage worth speaking of. When they are full grown they pupate in the soil and change into new beetles before the end of the summer. There is only one brood a year.

Control.—This pest can be controlled easily by spraying the plants with Bordeaux mixture, 4-4-40 formula, and one pound of calcium arsenate or one and one-half pounds of arsenate of lead powder to every forty gallons of the liquid. Apply the spray in spring as soon as the beetles are seen to be at all numerous and are attacking the plants. One application will sometimes be sufficient but often two, about ten days apart, will be required.

Stalk Borer (*Papaipema nitela*)

This is a somewhat slender caterpillar easily recognized by the conspicuous alternate white and brown longitudinal stripes on its back. The stripes often do not run the full length of the body but are missing on several consecutive segments on the front half. The adults are greyish moths which fly around in

late summer and autumn and lay their eggs chiefly on weeds. The eggs hatch in spring and the larvae feed largely on weeds but also attack corn, tomatoes and numerous other stout plants, boring holes into the stem and making tunnels in it. This tunnelling usually causes the plants to wilt and die. A single borer may enter into and destroy several plants. All the damage, as a rule, is done before August 1st. This borer is often mistaken for the European corn borer, but the latter does not have the white and brown stripes and does most of its damage after, not before, August 1st.

Control.—It seems impossible to destroy the stalk borer by spraying. The best method, therefore, is to cut all weeds as low as possible late in fall or early in spring and burn them to destroy the eggs before they can hatch. Where the weeds are in open fields, fall plowing or early spring plowing may be substituted for burning. Sometimes the borers in the plants are destroyed by taking a sharp knife, slitting the stem lengthwise and cutting through the borer, but this is seldom practicable.

White Flies (*Trialeurodes vaporariorum*)

These tiny insects are a great pest in greenhouses and if not combated soon increase so rapidly that they weaken the plants and often ruin or almost ruin the crop. As the name indicates, the adults are white. They can fly around freely, having four well-developed wings. The flies are very small, not more than one-sixteenth of an inch in length. The flies lay little pale green eggs on the under side of the leaves. These hatch into tiny greenish-white, oval larvae or nymphs, which attach themselves to the under side of the leaves and remain there motionless, like scale insects, until they become full grown and change into flies. There are many generations a year, and nearly every kind of greenhouse plant is attacked. White flies sometimes attack tomatoes and other plants outside, but only when there is a greenhouse nearby, because the winter kills all except those in the greenhouse.

The injury is done by both the adults and nymphs sucking the juices out of the plants, thus weakening them and making them pale and sickly. Often the plants become sticky and covered with a dark substance. This is due to the insects exuding what is known as honey dew, which gets everywhere over the plants and in which a black fungus often grows. White flies are usually the worst insect pest of greenhouse tomatoes.

Control.—Fumigation with hydrocyanic acid gas is the only satisfactory method of combating this pest. Four fumigations at intervals of about ten days are necessary for complete eradication. Full details of fumigation would take too much space in this bulletin, therefore those who have not had experience in fumigating greenhouses with this gas should write to the College for full directions.

Slugs

These are stout, legless, slimy, greyish creatures usually about three-quarters of an inch long when at rest and from an inch to an inch and a half long when in motion. They are always worse in moist seasons, moisture and shade being necessary for their existence. Feeding is done at night, and on tomatoes usually takes the form of eating holes into the fruit resting upon the ground. Numerous other plants besides tomatoes are attacked.

Control.—The most common method is to scatter hydrated lime heavily over the ground around the plants attacked so that the slugs have to pass through it to reach the tomatoes or to go from one tomato to another. Repeat the treatment after rains.

In the United States a bait, made of ten pounds bran, one-quarter gallon cheap molasses, about one gallon water, one-half pound of white arsenic or

one-half pound of Paris green, is used, apparently with good success. The bran and the poison are mixed together, the water and molasses mixed, and then the liquid poured over the poison bran and thoroughly stirred up. A small quantity of the bait is scattered over the infested area at dusk. Chickens, of course, must be kept away from this poisoned substance.

If young plants are attacked, the slugs can be kept off by spraying them with the ordinary Bordeaux mixture with or without poison.

Millipedes

In the fall of the year holes are often eaten into tomatoes by dark brown, thousand-legged worms (millipedes) which are often mistaken for wireworms because of their hard, slender bodies. They can, however, easily be distinguished from wireworms or any other insects by the fact that insects have only three pairs of legs whereas the millipedes have numerous legs, there being two pairs on each segment of the body. Like slugs, millipedes love moisture and work in shade and at night.

Control.—In greenhouses they are easily destroyed by fumigating with tobacco. Outside they can also be combated by tobacco extracts such as nicotine sulphate, forty per cent. This should be diluted as for other insects and sprayed heavily over the ground where they are. Tobacco dust scattered over the ground and then moistened would give as good results. It will seldom be necessary, however, to make any treatment in fields.

SEED SELECTION

Undoubtedly one of the greatest problems that confronts the grower of early tomatoes is the procuring of strictly reliable seed. If he is not satisfied with the seed procurable, he should undertake to develop a strain of his own selection. A system of selection will be given here which is applicable to the case of the ordinary grower.

The type of plant and fruit required that best suit your local conditions should constantly be kept in mind and set up as a standard toward which to strive.

If you have a field of tomatoes from seed which is true to variety and reliable, go through the field and select one or more plants which in every respect approach nearest to the ideal you hold in your mind. Mark these by staking them. Select healthy productive vines of which the fruit is most uniformly of the desired type, because the character of the seed is determined by the plant and not by the individual fruit. The fruit selected should be of medium size, smooth and well-shaped and, above all, the earliest to mature. The fruit should not be picked until it is thoroughly ripe and the seed may be extracted as follows:

Cut the tomato in two, crosswise; slip out the seed pulp into a pail or tub; let the pulp stand until the seeds are free from pulp but do not let the seeds sprout, then put in plenty of clean water, stir and break up the sour pulp until all the good seeds will settle to the bottom when left to stand a minute; pour off the top, then put in more water, repeating the operation again and again until the seeds settle in nearly clean water. Now drain off all the water you can; place the seed in a towel and press out the surplus water; the seed is then ready to spread out in some warm place to dry. Stir it occasionally until thoroughly dry. It is very important to keep the seed from each plant entirely separate; label, recording the date when it was saved.

Suppose that five plants were originally selected. The following spring the young plants from the seeds thus saved should be set out in a well-prepared piece of ground. Keep the progeny of each original plant entirely separate

one from another and from the main crop when set out into the plots. These plots should be labelled plainly and, as the plants grow, compare them with the original plants and with the standard type you have in view.

Select the plot in which all the plants come nearest to the desired type and which show the least variation. From that plot the best individual plants are selected, discarding all the rest as far as seed selection goes, and the seed from these plants is saved for continuing the breeding and selecting process. The seed from the remainder of the plants may be used for the main crop the following year, as it will produce plants above the ordinary quality. Such a course of selection is not hard to carry out and, if carefully done, should result within four or five years' time in the development of strains of seed greatly superior to that possible of purchase and such that will give more satisfactory results under the grower's own conditions.

Tomato seed, when kept under good conditions of storage, may be expected to give fairly good results when kept as long as three or four years.

PLANTS REQUIRED PER ACRE AT VARIOUS PLANTING DISTANCES

When estimating the number of plants necessary to be provided to plant an acre of ground to tomatoes, a surplus should be allowed sufficient to cover all losses, discarded weak plants and resets. For example, when setting out at four feet by four feet, which actually requires 2,722 plants, a good grower will usually try to have 3,000 plants per acre available.

Planting distances	Plants required
3 x 3	4,840
3 x 4	3,630
4 x 4	2,722
4 x 5	2,178
5 x 5	1,742

HOTBEDS AND COLD FRAMES

Location.—A hotbed should be placed on the south side of a building or high board fence so that it may be protected from the north and west winds and that the plants may enjoy as much sunshine as possible in the early spring. Where a large number of these beds are made they should be placed in parallel rows from two to five feet apart. This will give sufficient room for working in them and in handling the glass. They should also be close to a sufficient supply of water as this is required in large quantities throughout the season.

Construction.—Probably ninety-five per cent. of the hotbeds in Ontario are heated by the fermentation of horse manure. A small number are heated by steam pipes which are connected up with the boiler room of the greenhouse. The hotbed frame is generally made of either one or two-inch boards, although the former is most satisfactory if a little care is taken in building it. A standard sash being three feet two inches wide and six feet long, the frame should be made to conform to these measurements. For this reason a hotbed is five feet ten and a half inches wide and as long as desired. The back or north wall is six inches higher than the front; this is done for two reasons—to allow rain water to run off and to permit the sun's rays to enter more easily to all corners of the bed during the early spring days. In making up the bed many growers put in two by four scantling at the junctions of the sash; this gives support to the frame, keeps the wind or frost from entering between the sash, and helps in sliding the sash up and down for ventilation.

Making a Hotbed.—In making a hotbed it is necessary to have fresh horse manure with a small amount of straw in it, which gives better results if

it is cut in short lengths. The more grain the animals have consumed the better will be the heating power of the manure. As it is impossible for market gardeners to obtain the quantity of manure desired all at this time, they haul it during the winter and place it in shallow piles to prevent heating. Many of them cover over their piles of soil with this manure to keep the soil from freezing during the winter. When the period for making hotbeds arrives they mix this manure with fresh hot loads from the stable, thus starting the heating which is necessary in its preparation. When the manure has begun to steam freely the pile is turned over to thoroughly mix it so that fermentation takes place uniformly throughout the manure. It may be necessary to do this the second time to obtain the results desired.

In making hotbeds there are two types in use, the one wholly above ground and the other with the manure in a pit. The former is the commonest in use, although the latter does not require as much manure. With the above-ground hotbed we make a pile a foot larger each way than the size of the frame, building it up in layers of six inches, which are carefully tramped down so that no unevenness appears; any hollows are filled until the whole is level, then the next six inches are added. The height of the pile depends entirely on the time of year at which the bed is made and the temperature recorded. At the first of March and in a cold section three feet of manure would be necessary. In a warmer section not more than two feet would be necessary at that time. As the season advances the amount of manure lessens until, if one were making a hotbed the latter part of April, in most sections, six inches of hot manure would be sufficient. After the manure has been piled the frame is placed upon it and soil put in.

The amount of soil used will depend on whether flats are used in which to grow the seed or if it is sown directly in the soil. In the former case one inch is sufficient to keep the bottom of the box from touching the manure, in the latter from three to four inches are necessary. The glass is then put on the bed and the frame is banked with hot manure. This keeps the sides of the frame supplied with heat and keeps out any danger of frost. The bed is allowed to stand for three or four days, care being taken to ventilate on each day by lifting the glass a couple of inches for two or three hours. This allows the gases from the heating manure to escape. If necessary, a dairy thermometer may be placed in the bed; this will show a quick rise in temperature to more than 120 degrees Fahrenheit; it will then gradually fall to 90 degrees Fahrenheit when it is safe to sow seed. The growing of the weed seeds in the bed is an indication of this also. When this stage arrives the soil should be raked level, all sticks, stones and lumps being removed and then planting commences.

When manure is scarce the pit method may be used. This is done by digging a pit slightly smaller than the frame and about eighteen inches deep, which is filled with fresh manure, the frame put on and banked, as in the former.

Steam and hot water beds have the heating system around the walls of the frame just under the glass. One-inch pipe is used for steam and two-inch pipe for hot water. The flow is placed on the higher side of the frame, the return on the lower. Care must be taken to allow for a continuous dropping in the pipe level so that no air sockets can form.

Cold Frames.—A cold frame is simply a frame over a piece of ground; it has no heat except what may be gathered during the bright sunshine of the day. It is used largely for the hardening off of plants before field setting, though it may also be used for growing early crops. Where there is danger of freezing it can be banked on the outside with manure. It may be covered with either glass or cotton. The cotton frames are made the same size as the sash and will keep off a considerable amount of cold. It is handled similarly to the hotbed in other respects.

The field hamper is a very good type of container for factory tomatoes.

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Ontario Department of Agriculture

HORTICULTURAL EXPERIMENTAL STATION
VINELAND STATION, ONTARIO

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NUT CULTURE IN ONTARIO

Jas. A. Neilson, B.S.A., M.S., Extension Horticulturist

Japanese Walnut—Butternut Hybrid.
Grimsby.

The conservation and improvement of our native nut trees and the introduction of suitable species from foreign countries, offers great possibilities in making Ontario more productive and beautiful. This branch of horticulture, unlike fruit, flower and vegetable growing, has not received much attention in North America, except in the southern and western United States. In the southern States the pecan has been greatly improved and widely planted, and in the Pacific Coast region, Persian walnuts, filberts and almonds are extensively grown. As a result of this development, immense quantities of fine nuts are produced annually, and millions of dollars are added to the wealth of those sections of the United States.

The good results obtained in the south and west indicate that there are possibilities in nut culture for northern regions, where many kinds of fine native and introduced nut trees are found, and consequently, there has been considerable interest shown in nut trees in Canada during recent years. This interest has brought forth many enquiries regarding nut culture, and it is in response to this demand for general information that the present bulletin is written.

In the following pages an attempt will be made to give the latest information on the regional adaptation and cultural requirements of the various native and well-known introduced nut trees, and to show the possible value of some new species not generally grown. It is hoped that this data will be helpful to those who are interested in nut culture, and will stimulate others to become interested in this somewhat neglected but valuable branch of horticulture.

WHY NUT TREES SHOULD BE GROWN

There are many good reasons which may be advanced in favour of the more extensive planting of nut trees. Nut trees combine beauty with utility, and are therefore more valuable than other trees which are used only for ornamental purposes. They not only yield a nutritious food, but beautify the landscape, provide shelter, and furnish valuable lumber and fuel when their usefulness as nut bearers is over. The chief points in favour of growing nut trees are set forth in detail as follows:

(*a*) *For Food Production.* The food-producing possibilities of nut trees are not properly understood or appreciated by the public. Dr. Robert T. Morris, in his book on nut-growing, states as follows:

"Nut trees produce more of the food essentials in proteins, oils, and starches per acre than are furnished by ordinary field crops."

In support of this statement he offers the following data:

"Each acre of walnut trees in good bearing will produce every year food approximating: 2,500 lbs of beef, or 3,500 quarts of milk, or 3,000 lbs. of mutton."

This statement is based on results obtained in regions where the English walnut grows to perfection, and therefore are not to be taken as an easy possibility for southern Ontario, where the English walnut is on the northern margin of its growth. After making a liberal allowance for lower yields, due to climatic differences, these figures show that nut trees as a class have great food-producing possibilities, and will therefore, undoubtedly play an important part in the world's future food supply.

Canada imports great quantities of nuts every year from foreign countries, and must send out a large sum of money to pay for the same. At date of writing this amounts to approximately $5,000,000. There is not the slightest doubt but that a portion of this demand could be met by growing, in suitable areas, the best varieties of native and exotic species of nuts.

(*b*) *For Ornamental Purposes.* In addition to their value as food-producers, many nut trees are beautiful and make a useful contribution to our list of trees used for decorative purposes. The black walnut, when full grown, is a stately tree, and the Japanese walnut and its hybrids with their symmetrical form and tropical foliage are some of our most beautiful deciduous trees. It is rather difficult to understand why trees such as the Manitoba maple, horse-chestnut and Lombardy poplar are planted for ornamental purposes, when a more beautiful effect, and a valuable food besides, may be obtained by planting some of the best strains of native and exotic species of nuts.

(*c*) *For Timber.* While it is the chief purpose of this bulletin to show the food-producing and ornamental value of nut trees, the timber yielding possibili-

ties of some of these trees should not be forgotten. The black walnut is one of our most valuable timber trees, and is widely used for furniture, gun stocks and cabinet work. The hickory makes a valuable timber which is used extensively for carriage making and implement handles. The sweet chestnut is highly prized for interior trim in houses, because of the attractive appearance when finished in the natural colour.

Permanency and economy in production are other good points that may be advanced in favour of nut trees.

(*d*) *As Permanent Crops.* Nut trees in contra-distinction to other crops, which are of an annual or bi-annual nature, will yield good crops for a long period, provided they are given good care. The great age of some native nut trees is a proof of the permanency of nut crops.

(*e*) *For Economy in Production.* Nut trees require only a moderate amount of labour for cultivation and harvesting, and therefore can be grown at a lower cost than most other crops.

DESCRIPTION AND GEOGRAPHICAL DISTRIBUTION OF NUT TREES IN ONTARIO

The chief native nut trees are the black walnut, butternut (white walnut), hickory, chestnut, beech and hazel. Of introduced nut trees, there are Persian, Japanese, Manchurian, and Chinese walnuts, European, Japanese and Chinese chestnuts, pecans, almonds, filberts and tree hazels.

For convenience these various species will be discussed in groups rather than as native or introduced trees. The data relative to the distribution of the species described in this bulletin is based on information obtained through correspondence, personal observation, and the latest references. In so far as it pertains to native nut trees, it is believed to be accurate, but in reference to introduced nut trees, it may not be complete, as it is difficult to determine accurately the distribution of exotic nut-bearing plants.

THE WALNUT GROUP (*Juglans sp.*)

In this family there are seven representatives, the black, the butternut or white, the Persian (English), the Chinese, the Manchurian and two species of Japanese.

The Black Walnut (*Juglans nigra*)

The black walnut is one of our finest native trees. It grows to a large size, sometimes attaining to a height of 100 feet, and a trunk diameter of five feet. When grown in the open, it makes a beautiful symmetrical tree, having a large rounded crown with drooping lower branches. Contrary to popular belief, the native walnut grows quite rapidly, and in some cases bears early. From one lot of nuts planted by the writer, a tree grew to a height of thirty-seven feet, with a trunk diameter of fourteen inches in eighteen years, and began to bear in six years from planting.

The black walnut occurs quite abundantly in a belt of country bordering on Lakes Ontario, Erie, St. Clair, and Huron, but also has been planted north and east of its native region, and does well when protected from cold winds. It is not definitely known how far north the black walnut can be grown, but it is believed that it should not be planted north of a line extending from Ottawa to North Bay.

The native walnut will grow on a variety of soils ranging from heavy clay

to light sand, but will do best on a deep, fertile, well-drained sandy loam, or a light clay, with good moisture holding capacity and a plentiful supply of lime.

The nuts vary greatly in size, form, shell characteristics and flavour of kernel. The majority of nuts are roundish, but some are oval.

Black Walnut.
Horticultural Experimental Station, Vineland.

A few trees have been located which produce large nuts with a thin, easily-cracked shell and fine kernels. These superior sorts have been propagated and are now being sold as named varieties by those who specialize in nut trees. The Thomas, Ohio Ten-Eyck, McCoy, Morris, Lewis and Stabler are some of the best varieties now available for planting.

The Butternut or White Walnut (*Juglans cinera*)

The butternut, or white walnut as it is sometimes called, is much hardier than the black walnut, and has a wider distribution in Canada. It is found from New Brunswick westward through southern Quebec and Ontario to Manitoba. In southern Manitoba at Burnside, there is a grove of butternut trees that have grown to a fair size, and borne several crops of good nuts. These trees were grown from nuts introduced from Bruce County in Ontario, many years ago.

The butternut will grow on a variety of soils but, like the black walnut, succeeds best on a rich, well-drained loam. On suitable soils, it sometimes attains a height of seventy-five feet and a trunk diameter of four feet. When growing alone the trunk often divides into several branches, forming a triangular-shaped outline. Like most other nut trees, the butternut varies greatly in productiveness, some trees yielding very heavily while others yield light crops.

A few trees which bear superior nuts have been located and are now being cultivated. The Deming and Aitkin are two varieties now recommended for planting.

Japanese Walnuts (*Juglans cordiformis and Juglans sieboldiana*)

The Japanese walnut is represented in Ontario by two species. The common type, *Juglans sieboldiana*, and the heartnut, *Juglans cordiformis*. There are also hybrids between the Japanese walnut and the butternut that are erroneously called the Japanese walnut.

The *sieboldiana* and the *cordiformis* species are characterized by very rapid growth, early and heavy bearing and marked beauty of form and foliage. These trees are considered by some to be our most beautiful deciduous trees, and are worthy of much wider planting for ornamental purposes as well as for their nuts.

The trees generally have a vase-like outline with a broad, roundish, many-branched top. The leaves are a light green and quite large, often growing to a length of thirty inches. Many of the leaves hang down and produce a tropical effect which is quite beautiful. The bark is generally smooth and of a soft greenish gray.

Both species are believed to be as hardy if not hardier than the black walnut, having been grown and fruited in sections where the black walnut does not occur. The Japanese walnut has been planted to a limited extent in Ontario with Ottawa as the northern limit in the east and Clarksburg in the west. There are many fine trees of the common type growing in the region extending from Toronto westward to Sarnia and southward to the lakes.

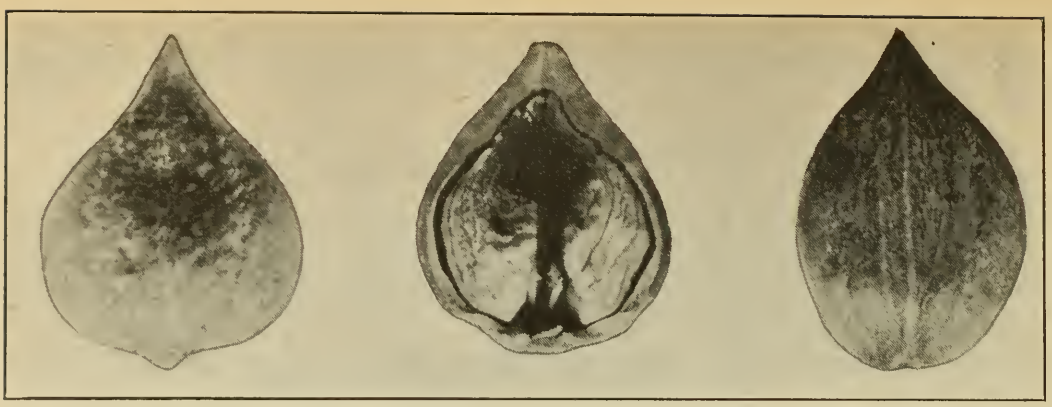
The heartnut is the most valuable of the two species for the production of nuts. The nuts are heart-shaped, have a thin shell, crack easily and contain a

Japanese Walnuts (Heartnuts)

a b c d

Left to right—(a) Heartnut, Scotland, Ont. (b) Nut split in halves showing kernel. (c) Heartnut, Jordon Station. (d) Nut split in halves showing kernel.

kernel of good quality with a flavour somewhat like the butternut. In the best varieties the shell can be split in halves by a light tap with a hammer and the kernel picked out whole with the fingers. This species is quite rare in Japan and still more rare in Canada and the United States. A few good heartnut trees have been located in Canada and the United States and are now being cultivated as named varieties. Of these varieties the Ritchey, Stranger, Faust and Gellatly are considered the best so far discovered. Other promising trees are under observation in Canada and will likely be recommended for propagation in the near future.



a b

Named varieties of Heartnuts. (a) Gellatly. (b) Faust.

The majority of the *sieboldiana* trees bear nuts somewhat like the butternut in outline but differ from the butternut in having a smooth shell. Some trees produce nuts that are almost round while other trees yield nuts that are broadly conic. There is also a great variation in the size of nut, thickness of shell and cracking quality. In some cases the nuts have shells that may be cracked quite easily and contain kernels which can be extracted almost whole, but in other instances it is difficult to crack the shells and extract the kernels.

The hybrids between the butternut and the Japanese walnuts grow even more rapidly than either of the parent types. One of these hybrid trees growing near Grimsby attained a height of thirty-eight feet and a trunk diamater of eleven inches in nine years from planting the nut. The hybrid between *Juglans sieboldiana* and the butternut appears to be quite hardy, having been grown and fruited near Quebec city. The nuts have a thick, rough shell which may or may not crack easily. The extremely rapid growth, beautiful luxuriant foliage and symmetrical outline makes these hybrids desirable as ornamentals while the nuts of the best specimens are as good as the butternut and are borne in much greater profusion.

Several interesting and rather valuable hybrids between the heartnut and the butternut have been found near Vineland and Jordan Station. The best of

a b c

Japanese Walnut, Butternut Hybrids. Left to right—(a) Juglans cinera x Juglans seiboldiana. (b) and (c) Juglans cinera x Juglans cordiformis.

these hybrids bears a nut that is almost a perfect combination of the characteristics of the two parents. The nut is nearly as large as an average butternut and has the form of the heartnut. The shell is rougher than the heartnut, but not so rough as the butternut. It can be easily split in halves and contains a kernel of heartnut shape with a flavour decidedly like the butternut. The husk has the stickiness of the butternut and, like the heartnut, it may be easily removed.

This tree has made an extremely rapid growth, being about thirty-five feet tall and over twelve inches in diameter at twelve years from planting.

The hybrids have occasionally been mistaken for the pure Japanese walnuts and in cases where poor fruited types were grown have caused disppointment, but where good nuts are produced they are as good if not better than the average of the *sieboldiana* species.

All of the Japanese walnuts, including the hybrids, will grow on a variety of soils but will generally do best on a deep, fertile, well-drained sandy loam.

The Persian (English) Walnut (*Juglans regia*)

The Persian walnut, as its name implies, is a native of Persia where it has been grown for thousands of years. From its native home it was carried by people in the remote past to Western Asia and Southern Europe and more recently to England. From England it was introduced into North America where it is generally known as the English walnut.

This member of the walnut family succeeds best in sections having moderate summer temperatures with a good rainfall and comparatively mild winters. It has been sparingly planted throughout the Niagara district, and appears to thrive

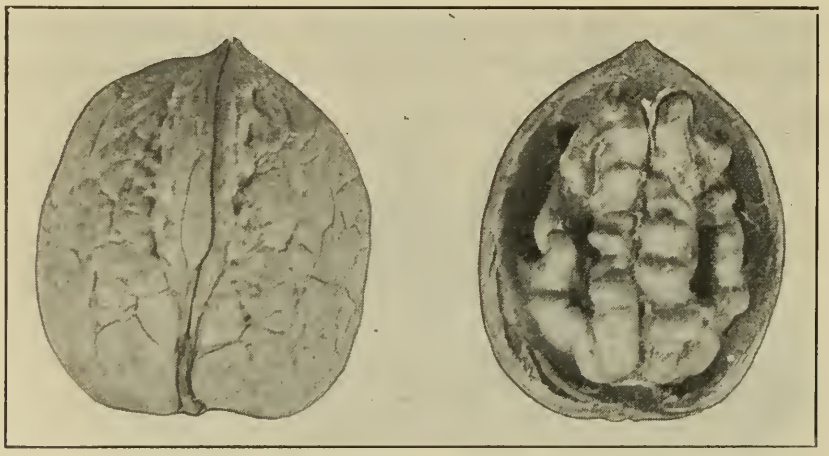
English Walnut.
Grimsby.

very well. In Southern Ontario there are about 200 seedling trees of bearing age besides several hundred more young trees which have not borne nuts. Approximately seventy-five per cent. of the bearing trees are found in the Niagara district and the remainder are chiefly in the Lake Erie counties.

In the Niagara fruit district some fine trees have been located in or near the following places: Hamilton, Grimsby, Beamsville, Vineland, St. Catharines, Port Dalhousie, Niagara-on-the-Lake, Queenston, St. Davids, Virgil, Fenwick, Niagara Falls, and Campden. Outside of this district thrifty trees have been located at or near Port Dover, Clarkson, London, Windsor, Chatham, Port Colborne, Hensall, Ridgetown, Kingsville, Cottam, Dresden, and St. Williams.

Under favourable conditions of soil and climate the trees grow quite large and make fine ornamentals. The largest and probably oldest tree in Ontario is located near Vineland village. It is about three feet in diameter and nearly sixty feet tall, and is said to be eighty years old. From this tree fourteen bushels of nuts were gathered in one season and other high yields have been occasionally secured.

The bark of the English walnut (especially on young trees) is a whitish gray and can readily be seen at some distance. The leaves are a medium dark green in colour and are rather pretty. The nuts from Ontario-grown trees vary considerably in their general characteristics. Some of the best trees produce nuts that compare favourably in size and quality with the best grades of nuts imported from California.



Seedling.
Grimsby East.

Inasmuch as the English walnut does best in regions having moderate winter and summer temperatures, it cannot be recommended for general planting except in the Niagara district and in the Lake Erie counties. As a general statement, the safe region for planting this tree would be in a section where the peach and sweet cherry are grown successfully.

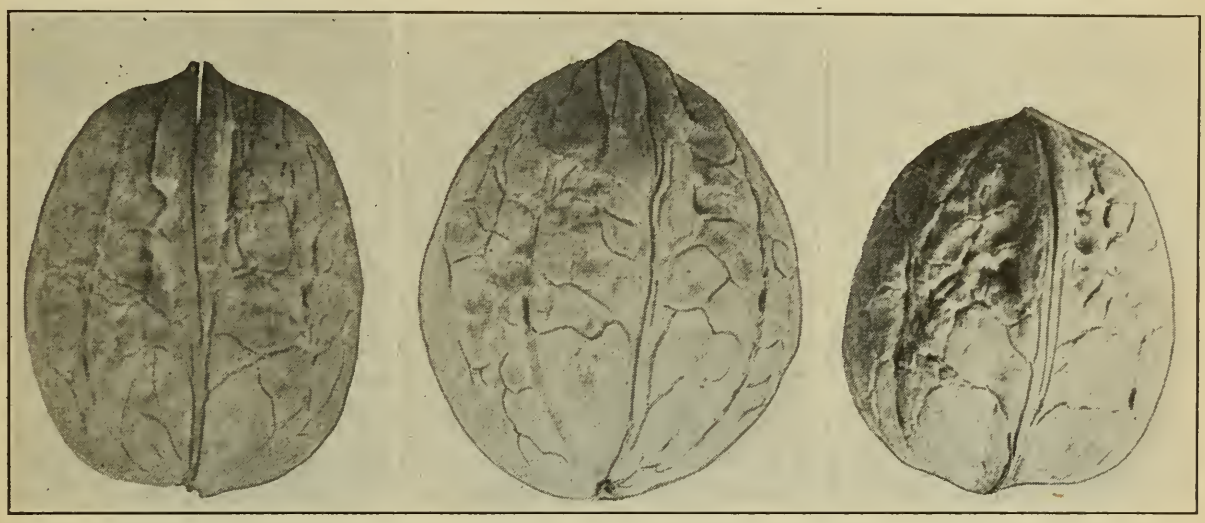
In very severe winters some injury to the terminal growth has occurred on the English walnut and therefore it is suggested that where possible it be planted on sites well protected from cold winds.

The soil requirements of the English walnut have not been definitely determined in this country but from observations made in recent years it appears to thrive on a deep, fertile, well-drained sandy loam or friable clay loam, well supplied with lime.

The English walnut in Ontario is grown mainly as a seedling tree, but in other countries where it has been cultivated more extensively and for a longer time it has been found to do better when grafted on the roots or trunks of the

Black walnut (*Juglans nigra*) or the Californian walnut (*Juglans hindsii*). In view of this fact it would appear to be good practice to procure trees for planting that have been budded or grafted on the native black walnut.

There are very few bearing trees of named varieties in Ontario, and therefore no definite statements founded on local experience can be made regarding the



Franquette. Hort. Expr. Station, Vineland Station.

Seedling of third generation. St. Catharines, Ont.

Seedling. Vineland Station.

best varieties to plant. Such recommendations as are made will have to be based on results obtained in the Northeastern United States where the climate is but very little if any better than the climate of the Niagara district or the Lake Erie section. The following varieties are suggested as being worthy of trial in

Pomeroy Seedling. Ruthven.

Pomeroy Seedling. Clarkson.

the peach and sweet cherry belt of this province: Mayette, Franquette, Rush, Holden, and Ontario. The last-named variety was obtained from a fine seedling tree in St. Catharines and is considered a promising variety for northern regions.

The Chinese Walnut (*Juglans regia sinensis*)

The Chinese walnut is the eastern form of the Persian walnut (*Juglans regia*), and is considered by some botanists to be practically the same species. It has been grown in China for thousands of years and is said to thrive in regions

where the climate is more severe than in North America where the Persian walnut can be grown successfully. For this reason some nut culturists believe that it may prove to be hardier than the Persian walnut and hence will be better adapted to the Northern United States and Southern Canada. It has been found to be hardy at the Arnold arboretum, Jamaica Plains, Mass., and should, therefore, be adapted to southern Ontario provided stock for planting were obtained from the most northern area of its growth in China.

The trees and nuts are similar in size and appearance to the Persian walnut, but the nuts, however, generally have a thicker and slightly rougher shell. The kernels are almost as good as the Persian walnut and if the same process of selection had been carried on in China as was done in western Europe and America the flavour and other desirable characteristics would doubtless be fully equal to the best Persian walnuts grown in the western hemisphere.

The Chinese walnut is now being tried at the Vineland Experiment Station, and at several other places in Ontario. The majority of these trees were grown from nuts which came from northwest China, but a few were obtained from the Bureau of Plant Industry at Washington. These seedling trees appear to be quite hardy, but it is too early to say definitely just how well adapted the Chinese walnut will be for our soil and climate. It is hoped, however, that it will prove to be hardier than its western prototype and will thus be useful in extending the range of the *Juglans regia* species in Canada.

The Manchurian Walnut (*Juglans manchurica*)

The Manchurian walnut is a native of Manchuria and Amurland in northeastern Asia. In its native land it grows to a height of sixty feet and makes a broad-headed tree. It is said to be quite productive and bears nuts somewhat like the butternut but with a rougher shell. The nuts are not particularly valuable and therefore it is not likely to be planted to any extent unless a tree can be located that produces nuts better than the average.

This species is very rare in Ontario, so far only two trees being found or reported. One of these grows near Chatham and the other is found in Whitby. The Chatham tree has grown very rapidly but has not produced any nuts. The Whitby tree has not made a large growth but has borne several very heavy crops.

Inasmuch as there are several other better species of walnuts in Ontario, this kind is not recommended for planting except as a rare ornamental.

THE HICKORY GROUP (*Carya sp.*)

The hickory belongs to the genus *Carya*, a division of the *Juglandaceæ* and is therefore closely related to the walnut. This family of trees was for many years thought to be confined to North America, but agricultural explorers have recently found representatives of the hickory in China. Fifteen species of hickory are known to occur in North America, and six of these are found in Ontario. Of these six, four are common, but only one is of much value as a nut tree.

The Shagbark Hickory (*Carya ovata*)

This is the most valuable native species for the production of nuts. It occurs in Ontario in the region extending from the southeastern shores of Lake Huron northeastward to the border of the Province of Quebec and southward to the lakes and the St. Lawrence. In Quebec it is confined to the southwestern section.

The shagbark occurs most abundantly and thrives best in the vicinity of the Great Lakes and their connecting rivers, but also does well at some distance from the lakes.

Where the soil and site are suitable the tree attains a large size, occasionally reaching a height of ninety feet and a diameter of three feet. When grown in the open it forms a few short, heavy limbs which make an outline resembling an inverted cone. The bark is rough and shaggy and peels off in long strips which curl up at the end, hence the name shagbark. The nut is surrounded by a thick husk composed of four sections, has a hard shell of varying thickness and contains a sweet kernel of excellent quality. It is highly esteemed by many people and is considered by some to be the finest nut grown anywhere. A few trees have been found which yield nuts with very thin shells and fine kernels. Some of these trees bear nuts with shells so thin that they may be cracked by a light tap of the hammer and may even be cracked with the teeth without difficulty.

Hybrid Hickory (Laney). Good types of Native Shagbark.

The following are considered good varieties of shagbark hickories and would be worth trying on a small scale in the native shagbark section: Hales, Kentucky, Kirtland, Seirs, Vest, and Weiker.

Other species of hickory are: The Bitternut (*Carya cordiformis*), the Mockernut (*Carya alba*), and the Pignut (*Carya glabra*).

The Bitternut has the widest range of any native hickory, occurring from Montreal westward to Collingwood and southward to the St. Lawrence river and the shores of lakes Erie and Ontario. The tree does not usually grow very large, being from fifty to seventy feet in height and one to two feet in diameter. The nut is rather small, has a thin shell and contains a kernel with an extremely bitter flavour, hence the name bitternut. The nuts are useless because of their bitter flavour, but the tree makes a good stock for grafting with superior types of Shagbark-Bitternut hybrids. It also offers interesting possibilities as a parent in crossing with desirable types of the shagbark and nothern-grown pecans.

The Mockernut is a tall tree and occurs in a strip of territory bordering on Lakes Erie and Ontario. It produces a large nut with a thick shell and a small kernel, which is generally disappointing, hence the name mockernut. Because of this undesirable characteristic it is not of much value as a nut tree, but, like the bitternut, it may be top-grafted to better sorts.

The Pignut grows from forty to sixty feet in height and up to three feet in diameter and occurs in the Niagara district and in the Lake Erie counties. The nut varies considerably in form and size and flavour of kernel. The usual shape is oval; some are pear-shaped, and others again are broader than long. In some

nuts the kernel is bitter while in others it is sweet. A few variations of this species have been located which are considered valuable for their nuts.

The Pecan (*Carya olivæformis*)

The pecan of commerce is a native of the United States and Mexico. In the United States it is found most abundantly in the region bordering on the Gulf of Mexico, but also occurs as far north as east central Iowa and central Indiana.

This fine nut tree requires a longer growing season and more heat units to mature a crop than are generally found in Ontario, and therefore it cannot be recommended for planting except where it is desirable to grow a rare ornamental tree which might occasionally produce ripened nuts.

Pecan trees have been grown for some years at several places in Ontario. In the vicinity of Richmond Hill there is a small grove of trees produced by planting nuts from southern Indiana. Some of these trees are fifty years old and are about thirty-five feet tall. They appear to be quite healthy but do not bear ripened nuts except in the most favourable seasons. There are also a few thrifty bearing trees near Simcoe which were grown from nuts obtained from Missouri, and at Niagara-on-the-Lake there is a small plantation composed of seedling and grafted trees. All of the pecan trees in Ontario appear to be quite hardy and the grafted trees particularly are making a good growth.

Hybrid Hickories

The intermingling of closely-related species, that occasionally occurs in nature, has produced some hybrid hickories that yield excellent nuts. Several of these good hybrids have been recently discovered and are now being cultivated as named varieties. One of the best is called Laney, in honour of Mr. Calvin C. Laney, superintendent of Rochester parks. It was found in Riverside cemetery near Rochester, and is believed to be a cross between the bitternut and the shagbark. The tree is a large, vigorous-spreading grower with beautiful foliage and rather smooth bark. The nuts are quite large with a very thin shell like the bitternut and a plump, sweet kernel like the shagbark.

The Beaver is another good hybrid between the bitternut and shagbark. It is a rapid grower, and makes a fine ornamental tree. Unlike most hickories it is said to bear early, especially when grafted on strong stocks. The nut is large with a smooth, white, thin shell of excellent cracking quality and contains a kernel of fine flavour. It is named after Mr. G. E. Beaver, of Millerstown, Pa., the owner of the property on which the tree was discovered.

In sections where the pecan, bitternut and shagbark hickory intermingle, natural crossing has also taken place between these species. One of these good hybrids was found in southeastern Iowa, on the farm of Mr. Fairbanks, and was given his name in recognition of the fact that he first brought the attention of nut culturists to the merits of this fine nut. The nuts are large with a light-coloured, smooth, thin shell which can be cracked easily and the meats extracted whole if care is exercised. The original tree is very prolific, having borne several crops in succession, and has survived the low temperatures which occur at times in the middle west.

Inasmuch as these hybrid hickories grow and yield well in sections of the United States where the climate is not any milder than in the Niagara district and the Lake Erie counties, it would seem to indicate that they could be grown successfully in that part of Ontario situated south of a line drawn from Toronto

to Sarnia. The fact that pecans have been brought from a region several hundred miles south of Ontario and grown in this province without any apparent injury even in test winters would also indicate that the pecan-bitternut hybrids, which should be hardier than the pecan because of the bitternut strain, would likely grow well and bear nuts in the milder areas of Ontario at least and might possibly do well where any native hickory thrives.

The hickory group will grow on soils varying from sandy loam to a heavy clay but will generally do best on a friable clay loam.

Hickory trees are attacked by a small beetle which feeds on the fruit of the peach tree and therefore should not be planted close to peach orchards.

THE CHESTNUT GROUP (*Castanea sp.*)

Representatives of the chestnut family are found in the temperate areas of Eastern North America, Europe, Asia, and Northern Africa. There are at least ten different species but of these only three, the Sweet chestnut (*Castanea dentata*) and the Chinquapins (*Castanea pumila*) and (*Castanea alnifolia*) are natives of North America.

The Sweet Chestnut (*Castanea dentata*)

This fine native tree is found in that part of Ontario extending from Toronto westward to Sarnia and southward to lake Erie. It has also been planted at several points outside of its natural range and appears to be doing well. Good specimens of these trees have been observed or reported as growing nicely at Ottawa, Newcastle, Goderich, Port Elgin and Midland.

Under favourable conditions of soil and climate it grows to a large size, sometimes attaining a height of ninety feet and a diameter of six feet. When grown in a dense stand it develops into a tall, straight tree but in the open it forms several heavy branches and makes a broad, round-topped head.

The nuts are borne in a prickly burr which contains from one to three specimens. These nuts are of good flavour and are high esteemed by many people, being considered superior to any other species of chestnut. The sweet chestnut is unfortunately subject to a fatal disease called chestnut blight (*Endothia parasitica*). This disease has destroyed hundreds of thousands of trees in the United States and has just recently been reported in Ontario. Because of the existence of this dangerous disease it is not advisable to plant the sweet chestnut near any native stands even though no disease is apparent as it will undoubtedly

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Chestnuts—Left to right. (a) Japanese. (b) Pargon. (c) Native Sweet.

appear and destroy all our native chestnut trees. Plantings of the sweet chestnut should therefore be made outside of the natural range or in well isolated sections within the natural range. Moreover, it is quite important to secure disease-free stock for planting.

EXOTIC SPECIES OF CHESTNUT

The Chinese Chestnut (*Castanea mollissima*)

Inasmuch as very few foreign chestnuts have been planted in Ontario, comparatively little can be said regarding their suitability for our conditions. The Chinese chestnut has been grown at the Arnold arboretum near Boston, Mass., and has been found to be hardy and more or less resistant to blight. This species is a small spreading tree rarely growing to thirty-five feet in height, generally much shorter, bears large, sweet nuts and is said to bear early and heavily. The flavour of the nuts is superior to the Japanese or European species and is almost as good as the native sort. The hardiness, productiveness, blight-resistance, good quality of nut, and precocious bearing habits of this species would indicate that it should be extensively tried in Ontario where the native chestnut is likely to disappear as a result of blight. It is also a beautiful tree and makes a desirable addition to our list of ornamental trees.

The Japanese Chestnut (*Castanea crenata*)

This species has been planted at a few places in Ontario and appears to be quite hardy. The tree is a small spreading grower, rarely attaining a height of forty feet. It bears early and heavily and produces very large nuts which are found in burrs, in numbers varying from three to seven. The flavour of the nut is inferior to any other known species of chestnut when eaten raw, but when cooked it is very good. The Japanese chestnut is reported to be moderately resistant to blight and should therefore be suitable for planting in Southern Ontario, especially outside of the region where the native chestnut occurs.

The Eurpean Chestnut (*Castanea sativa*)

This species of chestnut is variously known as French, Spanish, Italian and European chestnut. It is extensively cultivated in Italy, France, Spain and Portugal and it forms an important article of food for the people in these countries. It is also grown to a certain extent in southern England.

Like the native chestnut, it is susceptible to chestnut blight and therefore cannot be recommended for planting in Ontario except where it can be grown several miles distant from the native sort. A few good trees of this kind are growing and bearing well in the Niagara district and at a few other places in southern Ontario.

The chestnut family appear to do best on sandy soils but will also grow on light clay loam.

THE HAZEL GROUP (*Corylus sp.*)

Hazels of various kinds occur over a wide range of the earth's surface, being found in North America, Europe and Asia. There are at least fifteen different species and these vary in size from small shrubs of four to six feet in height to immense trees, 120 feet tall and six feet in diameter.

This family of plants is represented in Ontario by two native species, the common hazel (*Corylus americana*) and the beaked hazel (*Corylus rostrata*). The common hazel is generally a small bush from four to six feet in height, but the beaked hazel is usually larger. In the vicinity of Hudson's Bay it is reported as growing to the size of a small tree, and on the Pacific coast is said to attain to a height of thirty feet on suitable soils. The hazels are the hardiest nut-bearing

plants in Canada, being found from the Atlantic to the Pacific and from the southern boundary up to Hudson's Bay and the Peace River district.

The native hazels do not usually equal the European hazels in size of nut and productiveness but are extremely hardy, and would doubtless be worth planting where filberts and cobnuts cannot be grown. Superior strains of the common hazel have been discovered and are now being cultivated in the northern States and Canada.

Of the varieties now available for planting, the following are recommended: Rush, Merribrooke, and Winkler.

Filberts (*Corylus avellena*) and Cobnuts (*Corylus pomtica*)

These valuable nut-bearing plants are natives of western Europe and are extensively cultivated in England, France, Spain, and Italy. Both species were introduced into North America many years ago but did not make much progress, except in the Pacific Coast region, on account of being attacked by hazel blight (*Cryptosporella anomela*), a disease common to the native hazel, but not usually destructive on this host plant. On the European species, however, it proved to

Seedling Filberts grown in Ontario.

be quite destructive and has limited the culture of this valuable member of the hazel family, because its life-history and means of control were not properly understood. In recent years good progress has been made in the control of this disease and now it is not regarded as a serious drawback to the culture of these plants.

Filberts and cobnuts have been introduced into Ontario and are doing well. In some cases the trees are quite large, attaining a height of twenty to twenty-five feet and a diameter of from four to twelve inches. Good specimens have been found at Guelph, Grimsby, Simcoe, Vittoria, St. Williams, Port Burwell, Tyrconnell, Exeter, Ancaster, Port Ryerse, Glencoe, Cedar Springs, Chatham, and Watford. At Port Ryerse there is a small grove over sixty years old, and at Exeter, Tyrconnell, and Ancaster the trees range from forty to fifty years of age. These trees appear to be quite healthy and hardy and some are bearing fine nuts. The nuts vary from round to oblong and are larger than the majority of the native hazels.

The great majority of filbert trees growing in Ontario were introduced from England more than fifty years ago or were produced from these introductions, but, unfortunately, no records of varieties were kept and hence no definite data are available concerning these varieties. The fact that some of these original introductions have been growing for more than half a century is indicative of their hardiness, and if trees yielding the best nuts were selected for planting very good results might be secured even though no variety name is known.

The results obtained by experimenters in the northern United States with

hardy varieties from northern Germany, where the climate is more severe than in southern England, shows that some of these varieties are well adapated to the soil and climate of western New York and therfore should be well suited to southern Ontario. The following named varieties are suggested as being worthy

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Improved varieties of Filberts grown in B.C. (a) Pearson's Seedling. (b) Seedling No. 1. (c) Bullnose.

of a trial on a small scale, and if good results are secured, larger plantations could be easily made: Early Globe, Medium Long, Italian Red, Large Globe, White Lambert, Red Lambert, Minnas Zeller, and Merveille de Ballweller.

Pearson's Seedling, Barcelona, White Avelleine, and Du Chilly are varieties which have done well in British Columbia and are also suggested for trial in Ontario.

The Turkish Tree Hazel (*Corylus colurna*)

This gigantic member of the hazel family is a native of southeastern Europe and western Asia and extends as far east as the Himalaya mountains. In its native region it grows to a large tree often attaining a height of seventy feet and a diameter of two feet. This species has been successfully grown at Rochester, N.Y., Stamford, Connecticut, and other northern locations. One of the Turkish tree hazels at Rochester has grown to a height of thirty-five feet and is about sixteen inches in diameter. In seasons when the blossoms escape frost injury, it bears heavy crops of nuts similar to the native hazel in size and flavour of kernel.

There are also a few young trees in Toronto on the campus of the University, which seem to be quite hardy and are making a good growth.

The Chinese Tree Hazel (*Corylus chinensis*)

This species is found in western China and is the largest of all the hazels, sometimes attaining a height of 120 feet and a diameter of six feet in its native land. The nuts of the best strains are quite large and contain a kernel similar in flavour to our common hazel. This species has not been introduced into Canada, but is suggested as being worthy of trial in the milder parts of Ontario because of the satisfactory growth of its near relative, the Turkish tree hazel.

The Chinese and Turkish tree hazels are probably of more value as rare ornamentals than as nut trees in their present stage of development. These species may also be of importance to those who are interested in breeding nut-tree crops. In the course of time it may be possible to produce a larger fruited form of tree hazel by crossing the Chinese hazel with the best of the large-fruited types of filberts. Granting that a cross of this nature could be made and a hardy

tree secured, it should prove a desirable acquisition to the list of nut-bearing trees. The tree hazels are also promising as stocks for the smaller hazels and may be used to grow filberts in tree form.

THE ALMOND (*Prunus amygladus*)

The almond is closely related to the peach and is similar in size and appearance of tree and fruit to the peach. It is extensively cultivated in Italy, France, Spain and California and forms an important item of production in those countries.

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Almonds. Left to right—(a) Grown at Port Dalhousie.
(b) Grown at St. Williams.

There are two classes of almonds, the soft-shelled and the hard-shelled. The soft-shelled almond was developed in the warmer parts of the globe and therefore is not well adapted to northern sections. The hard-shelled almond, however, is hardier and will grow in any section where the peach does well.

The soil and climatic requirements of the almond are quite similar to the peach and like the peach it requires careful cultivation in order to do well. The blossoms appear early in the spring and hence are liable to be injured by spring frosts. For this reason it is much better to confine the planting of the almond to the immediate vicinity of the lakes bordering on the peach belt.

A few almond trees have been planted in Ontario in the peach belt and are making a rapid growth and bearing fair crops.

THE BEECH (*Fagus grandifolia*)

This beautiful native tree is one of the hardiest nut trees in Canada. It is found in Prince Edward Island, New Brunswick, Nova Scotia, Quebec and Ontario. In Ontario it is said to occur as far north and west as the eastern end of Lake Superior.

The smooth, clean, light-gray bark and the brown, lustrous twigs and shining buds make this tree an attractive one in winter and the numerous bright green leaves and pendulous branches make a handsome shade tree in summer. Under forest conditions the beech grows into a tall, straight tree but in the open it forms a large, rounded crown.

The beech is a slow grower and does not bear early or regularly. Because of these characteristics little attention has been paid to it as a nut tree. In sections where other good rapid-growing nut trees cannot be grown, it should be worth planting for its nuts.

The nuts are highly esteemed because of their good flavour. They are borne in a prickly burr, usually in pairs and are triangular in shape.

The beech thrives best on rich clay loams well supplied with lime. It will also grow on slightly acid soils, but does not bear well or produce plump nuts on this soil.

WHERE NUT TREES MIGHT BE USED TO ADVANTAGE

1. *For roadside and street planting.* Where the soil and site are suitable, nut trees should form a part of the planting material used to beautify our highways and streets. The Highways Departments of Ontario and some of the northern United States have done good work in planting nut trees along suitable portions of the public roads and much more remains to be done.

2. *For improving home grounds.* Most species of nut trees are very beautiful and can be used effectively to improve the appearance of both urban and rural homes. There should be room for at least one nut tree on the home grounds, and in a great many cases several might be planted without neglecting other desirable trees of purely ornamental nature. Nut trees thus used would contribute not only to the beauty of the home surroundings but also to the profit and pleasure of the owners or occupants of these homes.

3. *Hillsides or ravines.* Areas which are difficult to cultivate because of steep or rough surface or corners of fields cut off by water courses might be devoted to a nut plantation where suitable soils occur.

4. *For parks and school grounds.* Urban and rural parks and school grounds should have a good collection of all the hardy native and introduced nut trees as an educational feature as well as for ornamental purposes.

5. *For commercial plantations.* In the warmest parts of Ontario it would probably pay to establish small plantations of the best varieties of Black Walnuts, Japanese walnuts, hickories, filberts, and blight-resistant chestnuts.

CHOICE OF STOCK FOR PLANTING

As stated elsewhere in this publication, nut trees vary greatly in the kind of nuts borne. This variation is due to the fact that the vast majority of nut trees in this province are of seedling origin, and, like seedling fruits, do not usually reproduce true to the parent type. Because of the uncertainty of securing trees that come true to type from seed it is advisable to plant budded or grafted trees. This, of course, adds to the initial cost but when one considers that grafted trees usually bear earlier and heavier, and produce nuts of better quality than the average seedling tree, the extra price paid for these trees is a very good investment indeed. No up-to-date fruitgrower would think of planting an apple orchard composed of seedlings of unknown origin when more certain and much better results could be obtained by planting grafted trees of varieties valued for productiveness and quality of fruit. Precisely the same principle should therefore be followed in the choice of nut trees, even though only a few trees are wanted for beautifying the home grounds.

The above statements apply only to those who plan to grow nut trees for food production or ornament. Where timber production is the aim, seedling trees are recommended because of the lower cost of establishing a plantation.

Some of the hardier kinds of nut trees can be procured from our leading Canadian nurseries although as yet little budded stock is available in Ontario. In view of the interest shown lately in nut culture, a few of the leading nurseries in this province are already planning to extend their propagation of nut trees to

include some of the best and hardiest of the varieties that are now only available from certain nurseries in the United States.

WHEN TO PLANT

Nut trees may be planted in autumn or spring. If autumn planting is decided upon, the trees should be set in October, but if spring planting is preferred, they should be planted as early as soil and weather conditions will permit. The time will vary with latitude, altitude, site, soil and seasonal development, but generally in southern Ontario it would be in late April or early May. If the trees are completely dormant they can be planted in the latter part of May.

SPACING OF NUT TREES

Many of our ornamental and fruit trees have been planted too closely to get the best results in growth or yield. Overcrowding prevents the trees from attaining their proper development, reduces the yield of fruit, and mars the beauty of form. These undesirable features may easily be prevented by giving the trees plenty of room. Large trees like the black walnut, English walnut, shagbark hickory, butternut and Japanese walnut, should not be planted closer than fifty feet if grown in orchards, but if grown in rows along fences, they may be set forty feet apart. In cases where nut trees are to be used mainly for ornamental purposes, it might be desirable to plant closer for the sake of the immediate ornamental effect, but when the growth of the extra trees produces an overcrowded condition, they should be removed.

Small trees such as the Japanese chestnuts may be planted thirty feet apart, while the Chinese chestnut which is smaller yet, may be planted as close as twenty-five feet. Filberts which rarely grow more than twenty-five feet tall may be planted fifteen to twenty feet apart if grown as an orchard, but if grown in hedges for ornamental effect or protection, should be set from six to eight feet apart. Almonds are usually planted about twenty feet apart.

HOW TO PLANT NUT TREES

Nut trees are generally more difficult to transplant than fruit or other ornamental trees, and therefore require very careful treatment. While in transit from the nursery to the place where they are to be planted, the roots must be well protected against the drying action of sun and wind, as exposure to either agency, even for a short time, may prove injurious or fatal. Damp sacking, sphagnum moss or moist hay are good materials to cover the roots with during the journey from the nursery to the purchaser.

If it is not convenient to plant the trees immediately after they arrive, the bundles should be unpacked and the trees heeled in until wanted for planting. The soil surrounding the roots should be thoroughly soaked with water after the trees have been placed in the soil.

When ready to plant, the trees should be taken out, only as required, and planted immediately. While planting special care should be taken to protect the roots as suggested above.

Where a few trees are to be planted the holes may be dug as required and the trees set in immediately, but where a large number are to be planted, it is advisable to dig a considerable number of holes before commencing to plant, to permit the planters to proceed rapidly with the work. The holes should be made slightly

larger than the greatest diameter of the root system, and deep enough to allow the trees to be set at least two inches deeper than they were in the nursery row. In making the holes the surface soil should be placed in a pile at one side of the hole, and the sub-soil in a separate pile. Just before planting, all broken or bruised roots should be cut off with a sharp knife or clippers, and any very long roots cut back to the margins of the main root system. Cutting back of bruised or broken roots is recommended, because it prevents the ragged edges from decaying and leaves a smooth surface which generally heals over quickly, and the shortening of long roots for convenience in planting.

When ready to plant, make a small mound in the bottom of the hole with the surface soil, set the tree on this little mound, and sift the surface soil in around the roots taking care to fill every space. When the root system has been lightly covered, take hold of the tree and raise it gently for about half an inch and lower it again. This helps to fill up any vacant spaces with soil. The soil should then be packed very firmly about the roots, after which another layer of soil may be placed in the hole and firmly packed. This should be continued until the hole has been completely filled. The sub-soil should then be placed on the surface in the form of a small basin with the tree in the centre.

The soil should then be thoroughly watered immediately after planting, and if the weather is dry, other waterings should be made at intervals of a week or ten days until rains occur. A liberal watering at planting time helps the soil particles to settle closely and drives out air from the soil.

No stable manure should be mixed in with the soil during planting, as this material sometimes causes injury to the roots and makes a harbour for mice. It is much better to apply stable manure to the top of the soil after the trees have been planted. It is also important to keep manure or other vegetable matter away from the immediate contact with the tree trunk. A clear space of three or four inches should be left around each tree. Bone meal is said to give good results if mixed with the soil at the rate of one pound per tree at time of planting.

Newly planted nut trees should be protected against the attacks of mice and rabbits. This can be done by wrapping the tree trunks with galvanized wire netting or other good patent tree protectors. When applying such materials sufficient space should be left between the trunk and the netting to allow for diameter growth, and the protective material should extend up the trunk for sixteen to eighteen inches.

PRUNING AND TRAINING NUT TREES

Experience has shown that grafted nut trees do better when a part of the top is cut back before or directly after planting. This reduces the demand for food on the roots, and is said to cause the formation of feeding rootlets, thus helping the tree to become better established in its new location. The portion cut back will depend upon the height of the tree and the percentage of roots lost in digging. Generally from one-third to one-half of the top should be cut back, but where a very rank growth has taken place, two-thirds may be removed. Nurserymen generally cut back the trees before shipping unless requested not to do so.

Trees cut back in this manner will usually produce several strong shoots. This new growth should be allowed to remain until the tree is well established. Usually this takes two to three years from planting.

The strongest and most upright of these new shoots should be selected as a central leader. From this central leader other branches will grow and these can be used to form the head.

In choosing the foundation branches, it is advisable to select those that are evenly placed around the circumference of the tree and well distributed along the vertical axis, so as to produce a strong well-balanced top. All branches in excess of those required to form the new framework should be gradually removed, as other branches develop on the foundation branches. The subsequent pruning should be confined to cutting out broken, dead or diseased branches, or those that interfere with other more desirable branches or which tend to make the tree unshapely.

Experiments in the pruning of young non-bearing fruit trees show that a much faster growth and earlier fruiting are obtained where very light pruning is practiced. While no definite data are available on nut trees, it is believed that the same results would be secured, when little pruning is given. The reason for the faster growth of lightly pruned trees is due to the fact that such trees have more numerous branches and a larger leaf surface than heavily-pruned trees, and consequently there is a greater amount of plant food manufactured and made available for growth.

In cutting out branches it is desirable to make close clean cuts and to paint all exposed surfaces over one inch in diameter, with white lead and linseed oil.

Sunscald, a form of climatal injury, sometimes occurs on the trunks and large branches of the English and Japanese walnut. When this is severe enough to kill the bark, some remedial treatment is necessary. Injured areas should be scraped clean of all dead or decaying tissue, and the exposed surface painted over with good protective substances, such as white lead and oil, coal tar or asphaltum.

CONSERVING WATER FOR TREES

Where trees have been planted on hillsides some method should be employed for conserving the rainfall for the use of the trees. This may be accomplished by terracing the face of the hill, and setting the trees on this terrace, or by making a saucer-shaped area six feet to eight feet around each tree. Where long terraces are made, it is advisable to have this terrace on the same level horizontally. The down slope side of the long terrace and the margins of the basin should be raised six inches to eight inches to hold water as it runs down hill during heavy rains. In cases where the area around trees only is terraced, the amount of water may be considerably increased by cutting two trenches or furrows from the tree diagonally across and up the face of the slope, to a point near the trees in the upper row. These furrows which run across the slope are thus able to catch and convey to the trees water that would ordinarily run off and be lost.

Where this method is employed it will be necessary to examine the terraces occasionally to see that they are not filling up by erosion from the furrows. If this occurs, the soil thus deposited should be removed to the rim of the terrace.

The terraces or basins should have a drainage outlet made opposite each tree during the late fall. Unless this is done, water is liable to accumulate in the depression around the tree after the ground has become frozen, and injure the lower part of the trunks. In the spring these openings should be closed to prevent loss of water during the growing season.

SOIL TILLAGE AND FERTILIZERS

The culture of nut-bearing trees in Canada is in its infancy, and consequently there is very little data available on the best methods of soil management and fertilizers for these trees. Unlike fruit trees, which are usually grown in plantations, nut trees are or may be planted in many different locations as a means of utilizing waste spaces, and therefore it is somewhat difficult to make general recommendations that would be suitable to the varied places where nut trees are grown.

There are however, certain factors which affect the growth and fruitfulness of all food-bearing trees. The most important of these, apart from temperatures, are the food and moisture supply. Where optimum food and moisture conditions exist, there is likely to be a good growth of tree and yield of nuts, but where these essentials are lacking, the reverse is likely to occur.

Freedom from competition is also another important factor in tree growth. As previously noted this may be obtained by giving the trees plenty of space and also by preventing the growth of other plants in the area from which the tree draws its food.

Where established nut trees are making a satisfactory growth, and are bearing good crops, it may be assumed that their requirements are being met, and therefore no particular attention is needed. In cases where growth or fruitfulness are unsatisfactory, and where these troubles are not due to disease or injury, there is clearly a need for attention in the matter of fertilizers and tillage of soil. For conditions such as these, and for the benefit of those who may plant nut trees on hillsides, along fences, roadsides, or as specimen trees, it is suggested that the soil space surrounding the trees be kept free of weeds or grass, and well supplied with humus-forming material. This may be done by digging in stable manure around the tree early in the spring, and by hoeing at intervals during the summer. Mulching heavily with manure or other suitable material is also an economical and easy method of soil management for trees. Where this method is used, the mulch should be deep enough to smother all weed growth and should cover an area equal to the spread of the branches. This method is especially valuable for steep hillsides or other places where it is difficult to cultivate the soil.

Where trees are grown on town or city lots, or where it may be undesirable or costly to use mulching material, artificial fertilizers are suggested as a substitute for stable manure. For this purpose, fertilizers containing nitrogen and phosphorus are said to be valuable. Nitrate of soda and ammonium sulphate are good sources of nitrogen, while bone meal and acid phosphate provide phosphorus. The proper amount of each element to apply to a tree will be determined by the size and condition of the tree. A small tree with a spread of branches not greater than five feet would probably require about one pound of nitrate and two pounds of phosphate per year. For larger trees, it is suggested that these quantities be added for every five feet increase in the spread of the branches.

In cases where nut trees are to be grown in orchards on good easily-tilled soil, the methods of soil management used for fruit trees would probably be quite satisfactory. After planting and until the trees reach a profitable bearing age, inter-crops may be grown. Crops such as beans, corn, potatoes and root crops which require early summer cultivation are generally best for this purpose. However, it is not considered good practice to grow one class of crop for several years in succession on the same area, and therefore other crops such as cereals or legumes may be grown for a change. In any system of inter-cropping, special

care should be taken to keep the area surrounding the tree free of all plant growth. This crop free area should equal that covered by the spread of the branches, and should be gradually extended to keep pace with the top growth.

After the trees attain a profitable bearing age a system of clean cultivation during the early summer, followed by a cover crop, might prove to be the best treatment. At any rate, this system has given good results in fruit growing, and would probably be just as satisfactory for nut trees. In this system, the soil is cultivated at intervals until about July 1, after which a cover crop of some kind is sown: red clover, sweet clover, rye and vetch, rape or buckwheat may be used for this purpose, but the best results are likely to be obtained when legumes are used.

Cover crops are generally plowed under in the late autumn or early spring, and the soil again cultivated until time to sow another crop.

SPECIAL NOTE

The author of this bulletin is particularly anxious to learn of the location of seedling trees which bear nuts of fine quality. This information is sought so that the best trees may be propagated, provided they are as good or better than varieties already located. Readers of this bulletin are therefore requested to report the occurrence of superior trees of any native or introduced species growing in Ontario, or elsewhere in Canada.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

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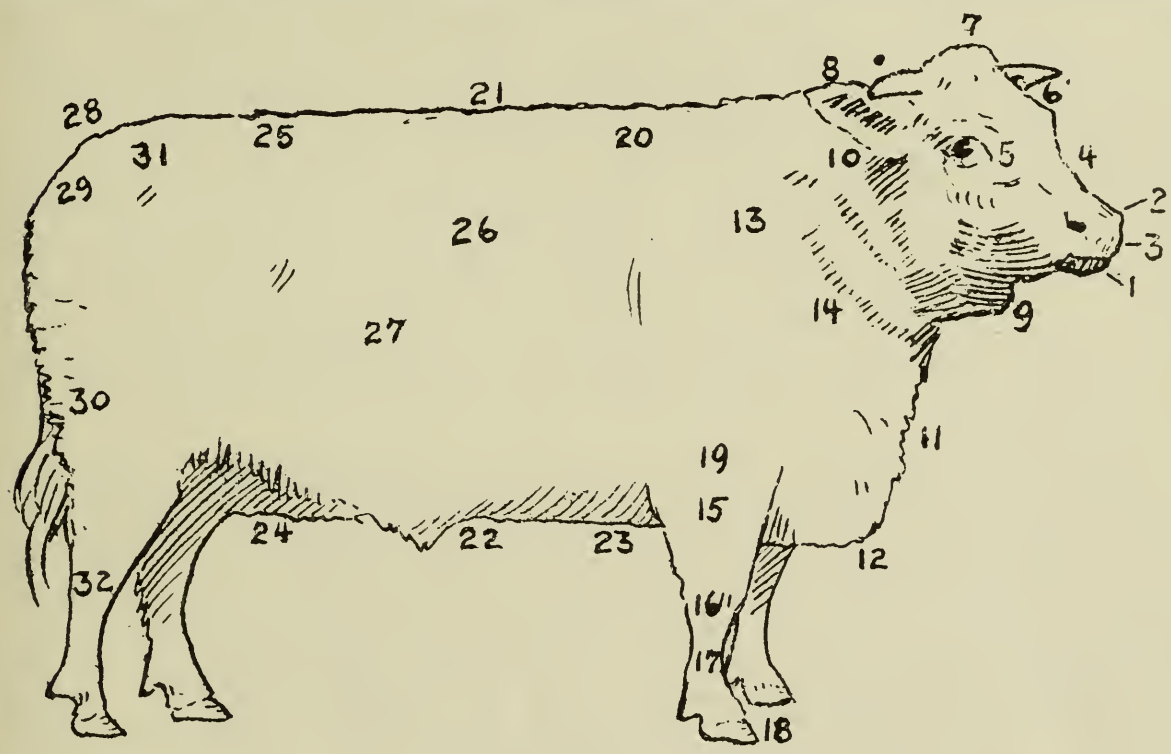
Beef Cattle

Wade Toole, B.S.A., M.S., Professor of Animal Husbandry



POINTS OF BEEF ANIMAL

1. Mouth
2. Nostrils
3. Muzzle
4. Face
5. Eye
6. Forehead
7. Poll
8. Ear
9. Throat
10. Neck
11. Dewlap
12. Breast or brisket
13. Shoulder
14. Neck vein
15. Arm
16. Knee
17. Shank
18. Hoof
19. Elbow
20. Crops
21. Topline or back
22. Underline
23. Fore flank
24. Rear flank
25. Hook bones
26. Spring of ribs
27. Barrel or middle
28. Tail head
29. Pin bones
30. Thighs
31. Rump
32. Hock

POSITION OF THE BEEF CATTLE INDUSTRY IN ONTARIO

Notwithstanding the rapid increase in dairying in Ontario, due to the great growth of urban centres in the last two decades, there are still more beef cattle than milk cows in the Province, and beef raising must continue to be one of the foremost branches of our live stock industry. According to the last report of the Statistics Branch of the Department of Agriculture, there are in Ontario 1,265,965 milk cows valued at $69,938,194 and 1,572,122 other cattle valued at $39,528,872, with a total of 2,838,087 cattle worth $109,467,066. Ontario's cattle industry is already a hundred-million-dollar industry and

two-fifths of this value is held in beef cattle. While a large percentage of the cattle classified in the Statistics Branch report as "other cattle" are undoubtedly young cattle and some are probably dairy heifers, the fact remains that the value per head is low, which would indicate that there is room for improvement in type and quality and that the greatest efforts of the breeder at the present time should be put forward toward better beef cattle rather than more cattle of the kind. Improvement in type and quality should now be the aim of the breeder and feeder of both pure-bred and market beef cattle. It must be remembered that the ultimate end of all beef cattle is the butcher's block and the requirements of the market must be given closer attention than ever before. While producers are anxious to maintain numbers, which are now practically one-quarter of the beef cattle of the entire Dominion, every effort should be made to improve the average quality of cattle bred and marketed for beef. Dairying will progress with the advance in population and industry, but beef raising must also go ahead. There are many large areas in Ontario better suited to beef raising than to the production of milk and milk products. The beef cattle industry must be pushed forward. It cannot stand still. Unless steady progress is made it must slip back. The great danger is carelessness in breeding which, in some cases, tolerates the mixture of dairy blood with that of the beef type with undesirable results. Good beef cattle only come from the use of sires and dams of the beef breeds. Crossing and intermingling the blood of the two types does not result in satisfaction for the breeder, feeder, butcher or consumer. *Better beef cattle for better beef should be our slogan.* Ontario can produce them.

Cattle sold or slaughtered from Ontario farms range each year from 800,000 to 1,000,000 head. Of course these figures include cattle of all types. In the number will be some 200,000 calves, largely of dairy type, but the magnitude of the cattle meat industry is large and is sure to increase. In studying the grading of cattle at the large stock yards, one cannot but notice the high percentage of common and inferior stock offered. Particularly is this true in the lighter weight steer classes and in the heifer and cow classes. The cow classes usually contain more inferior than good cattle. Perhaps this is an indication that feeders are thinning out the culls or it may be that there are still too many of the wrong kind on the farms. Practically one-sixth of the heavy steers marketed in 1923 through Ontario's public stock yards were "common", and nearly forty per cent. of the lighter weight steers were placed in the same category. Of the heifers, thirty-two per cent. were "fair" to "common", and over fifty per cent. of the cows graded "common." There seems to be room for improvement in quality and to that end every effort should be made.

Present day market demands must be recognized. The meat-eating public demand choice cuts off light carcasses. While the removal of the British cattle embargo has opened up a certain amount of trade in and made a market for heavy export steers and heavy feeders, the greatest demand is for the so-called handy-weight cattle from 900 to 1,000 pounds on foot and well finished. Ontario, built and equipped as she is, should be in a position to supply these lighter choice cattle. Winter feeding facilities are found on most farms, and feed is produced on these farms to grow and finish the cattle quickly. Overfat, heavy, old cattle have had their day. All that is asked for now is cattle of the right type carrying only sufficient age to ensure flavour and producing a carcass from which may be cut small but choice cuts to suit the modern small families' taste for tender lean. This means that good type is necessary in the cattle and

early finish is essential. Cattle from eighteen to thirty months old meet the best sale provided they are well finished. The Ontario breeder's and feeder's problem is to supply the market with something very close to baby beef with a few heavy cattle for export and as few culls as possible. This being true, what is the best type?

BEEF TYPE

The beef animal must be low set, deep of body, very thick, and must show a strong, straight top and a straight underline carried well down at the fore and rear flanks. In fact, the best type is filled out in conformation to give the appearance of almost a perfect rectangle. It is important that the portions of the body which furnish the best cuts in the carcass should be well developed. This means a great spring of rib and wide, deep loins and well filled rounds. In general appearance the beef animal should show close to the ground with all the depth and thickness to make a well-balanced animal.

The head generally indicates what goes behind it. A short, broad head and a large, strong muzzle, a short face, wide between the eyes and at the poll, is generally an indication of a good feeder and almost always goes with the thick, low down kind. The neck should be short and thick but the junction of the head and neck should be clean cut with an absence of throatiness and with a light dewlap. The filling at the neck vein at the junction with the shoulder should be smooth and the shoulder should be well set into the body and covered with flesh showing wide on top, which indicates a large amount of lean meat under the shoulder blades. Prominent, rough shoulders are very objectionable, because they generally go with an animal that is heavy in front producing too large a percentage of cheap meat. The shoulder should blend well into the body leaving no depression in heart girth. This means that the animal must show a great spring of rib which should be carried well down to the fore flanks, giving plenty of capacity on the floor of the chest which should end in a full, blunt, firmly carried brisket. The spring of rib, so necessary to constitution and wide and full to give floor space for the laying on of an abundance of flesh in the region known as the prime rib, should be carried right back over the body giving the animal a large middle and capacity to handle feed in sufficient quantity to make good beef cheaply. The top line and underline should be straight and parallel. Straight tops denote strength and generally speaking the flesh is laid on more evenly on straight backs than on weak or hollow-backed animals. A straight underline means that the animal is equally well let down in fore and rear flanks. An animal cut up in fore flanks generally lacks constitution and one cut up in the rear flank is almost invariably light through the thighs or buttocks. The loin, one of the most valuable parts of the animal, should be broad and deep and well covered with meat, with the hook bones set smoothly into the body so that the animals will hang a straight side of beef. The rump between hook and pins should be long and level and well and smoothly fleshed. The good beef animal is low in the twist, thick through the thighs and carries the meat well down to the hocks. The legs, while short, should show a fine quality of bone, heavy enough to carry the body weight, but not coarse and rough. Over the entire body there should be a wealth of natural fleshing, smoothly laid on with an absence of patchiness or rolling. The flesh should be mellow in character, firm but not hard and tallowy nor yet soft and flabby. The skin should be soft and pliable, not too thick nor yet too thin. Papery hides generally go with poor feeders, and thick, heavy, leathery skins generally denote lack of quality. In sizing up a beef animal, it must always be remembered that the high-priced cuts of meat come from the upper part of the

body, from a point behind the shoulder right over the back and down the hind quarter. This portion constitutes about half the carcass and it is in this region that the butcher gets his best meat, but the breeder and feeder must remember that depth of body, constitution and middle are necessary to the development of this choice meat down the back. To show the importance of the so-called best cuts of meat and their relation to conformation it may be stated that the loin and prime ribs, which constitute the most valuable cuts in the carcass, make up, on the average, about twenty-six per cent. of the carcass, seventeen per cent. being loin and nine per cent. being ribs. This amount, which is approximately one-quarter of the carcass, is actually worth nearly fifty per cent. of the entire value of the carcass. The rounds, on the average, constitute about twenty-three per cent. of the carcass when the rump is attached. Next to the loin and ribs this is the most valuable cut and with the loin and ribs comprises about three-quarters of the value of the carcass. The chuck constitutes about twenty-six per cent. of the carcass and is largely made up of the shoulder. It is comparatively cheap meat but is worth a little more than plates, flanks, shanks, etc., which constitute the remaining twenty-five per cent. of the beef carcass. We give these figures here simply to show the importance of the best possible development of loins, ribs and rounds in the beef animal and also to show the reason why light briskets, smooth shoulders, and trim underlines are asked for in the finished beef animal.

Scale of Points

The following is a satisfactory scale of points for beef cattle:

		Possible Score
Estimated weight	pounds	
Weight, according to age		4
Form, deep, broad, low set, smooth; top line and underline, straight		8
Flesh, naturally thick fleshed. (See further under quality)		4
Quality, bone strong, but of fine texture and clean; skin, pliable and elastic; hair, soft and thick. All parts evenly covered with firm flesh, which should be mellow to the touch, but not soft and flabby nor yet in hard rolls or ridges		8
Style, active and vigorous, but not restless; should show strong character		4
Muzzle, broad and clearly defined; mouth, large, nostrils, large		2
Eyes, large, prominent, clear and placid		2
Face, short, with clean cut appearance		1
Forehead, broad		1
Ears, medium size and fine texture		1
Neck, thick and short, with full neck vein; junction of neck with head clearly defined. In bull, crest well developed		5
Horns (when present), fine in texture, flattened at base, not more than medium size		...
Shoulders, smooth, covered with flesh, well laid back into ribs, compact and moderately broad on top		5
Brisket, prominent and blunt; breast, full and wide		3
Dewlap, light		1
Legs, straight and short; arm, broad and well muscled; bone, flat, clean and strong		2
Chest, deep and wide; fore flanks, full; space back of shoulders well filled, leaving no depression; heart girth large		9
Ribs, long, well arched; thickly fleshed		5
Back, broad, straight, well fleshed and smooth		7
Loin, deeply fleshed, coming out full to hooks and carrying width evenly from hooks forward		5
Flank, full and even with underline		3
Hooks, wide, but smooth and well covered, not prominent		4
Sirloin and rump, straight on top, long, wide, well filled between hook and pin bones, smooth		5
Pin bones, wide apart, smooth, not patchy		2
Tail head, smooth, in line with back; tail, fine, falling at right angles to top line		1
Thighs, full, deep and wide		3
Twist, full and deep, nearly as low as flank		3
Legs, straight and short; bone, flat, clean and strong		2
Total		100

BREEDS OF BEEF CATTLE

While there are a large number of breeds that are used for beef, only a few of these breeds which may be classified as beef breeds are extensively bred in Ontario. Chief amongst these breeds are the Shorthorn, Hereford, and Aberdeen Angus. In fact, these are the only beef breeds which have made any considerable progress in the Province. It is true that other breeds such as the Galloway and Devon are, or have been, bred in Ontario, but they never have made headway. The Brown Swiss and the Red Polled are also sometimes considered beef animals but they are more of the dual-purpose type and have never become popular in Ontario. The West Highland, a distinctly beef breed, is another that has not come into prominence in the Province.

It will be noted that all these breeds named had their origin in the British Isles with the exception of the Brown Swiss. The establishment of the breeds in Ontario marks the beginning of progress toward a diversified agriculture in this Province. Mixed farming in Ontario really had its beginning with the establishment of the live stock business through the importation of breeding stock from the Old Land.

The Shorthorn

The Shorthorn breed, which has always been the most popular amongst the beef cattle breeds in the Province, had its origin in the counties of Durham, Northumberland, York and Lincoln in the north-east portion of England, bordering on Scotland and the North Sea. This portion of England comprises a rich valley district with rolling land on either side. It is claimed that cattle somewhat resembling the present-day Shorthorn were bred by the dukes and earls in Northumberland and York before the year 1600. Of course, the origin of the breed is obscure. No doubt, cattle brought in by the Romans, Normans and other invaders were crossed with English stock. Black-horned cattle were common in Yorkshire, while in Lincoln, white, red and spotted cattle prevailed. Early in the eighteenth century the Teeswater cattle, produced in the valley of the Tees, became famous, while in Yorkshire the Holderness cattle were the favoured breed. Later, the Teeswater cattle were called Durhams.

About 1780, after the foundation had been laid by the use of two great bulls, Studley and Hubback, Robert Bakewell, who had been carrying on experimental work with sheep, discovered that by a close concentration of blood of choice animals rapid improvement could be made, and following this system the Colling Brothers, Charles and Robert, between 1780 and 1800, made the first systematic improvement of the breed, the former working at Barmpton and the latter at Ketton. These men were followed by Thomas Bates, Thomas, John and Richard Booth and Amos and Anthony Cruickshank. The Collings originated among others the following families: Phoenix, Wildair, Princess, Red Rose, Bright Eyes and Daisy families. They were interested in big, strong, deep, thick, heavy cattle noted for their beef producing qualities. The herd of Charles was dispersed at auction in 1810, and in 1818 and 1820 Robert sold out his cattle.

Following the work of Collings, Bates, who was born in Northumberland in 1775 and who commenced breeding Shorthorns in 1800, paid more attention to milking qualities and pedigree than to individuality, and by practising inbreeding to the extreme, finally injured the fecundity of his most famous family strain, the Duchess. The Bates herd was dispersed in 1850 just after the death of this great breeder who developed the Duchess, Oxford, Waterloo, Cambridge Rose, Wild Eyes and Foggathorpe families.

Contemporaneously with the work of Bates was that of the Booth family who started in Shorthorns about 1790, using as the foundation of their herd stock purchased from the Collings. The Booths, including Thomas and his sons, Richard and John, stuck strictly to beef type, using large, roomy, rather rough cows with which they mated bulls of the thick, smooth, low down, blocky type. They originated such families as the Isabella, Halnaby, Bracelet, Moss Rose, Cherry Blossom and Blossom of Fairholm.

It was not till about 1837 that Amos Cruickshank, an Aberdeenshire Scotchman born in 1808, and who had recently taken possession of a farm called Sittyton, began breeding Shorthorns. This real founder of the modern Shorthorn type made careful selections from English herds, always picking the smooth, deeply fleshed, blocky, low-set types, and commenced breeding what later became known as Scotch type Shorthorn cattle. He, with his brother Anthony, made wonderful progress in the breeding of Shorthorns up until the time the herd was dispersed in 1889. The Cruickshanks originated many of the great Scotch strains of Shorthorns as we know them to-day, including the well known Violet, Venus, Duchess of Gloucester, Matchless, Broadhooks, Roan Lady, Nonpareil, Sittyton Butterfly, Orange Blossom, Clipper, Victoria, Lancaster, Brawith Bud, Secret, Lovely, Cicely, Barmpton Rose, Mysie, Buckingham, Bellona, Spicy, Lavender, Village and other families.

Following the Cruickshanks, and breeding the same type of cattle, came many noted breeders. Among them, Sylvester Campbell of Kinellar, who originated the Kinellar Nonpareil, Miss Ramsden, Golden Drop, Bessie, Mina, Rosebud and Clementina families. Campbell's herd, which was founded in 1847, was dispersed in 1897, some six years after the death of the owner.

Mention should also be made of W. S. Marr who founded a herd at Uppermill in 1881 and who founded the Missie, Marr Maud, Princess Royal, Alexandrina, Roan or Red Lady, Bessie, Clara, Emma, Goldie, Flora, Stamford and Marigold families.

Along with Marr, the Bruce family did considerable work in improvement of the Scotch Shorthorn, originating two of the greatest families of the breed, namely, the Augusta and Rosewood families. They also originated the Mayflower and Averne families.

The Duke of Richmond, working with the same type, originated the Wimple, Jilt, Lustre, and Rosa Hope families, while J. B. Manson developed the Kilblean Beauty, and Shepherd laid the foundation of the Rosemary and Lovely families.

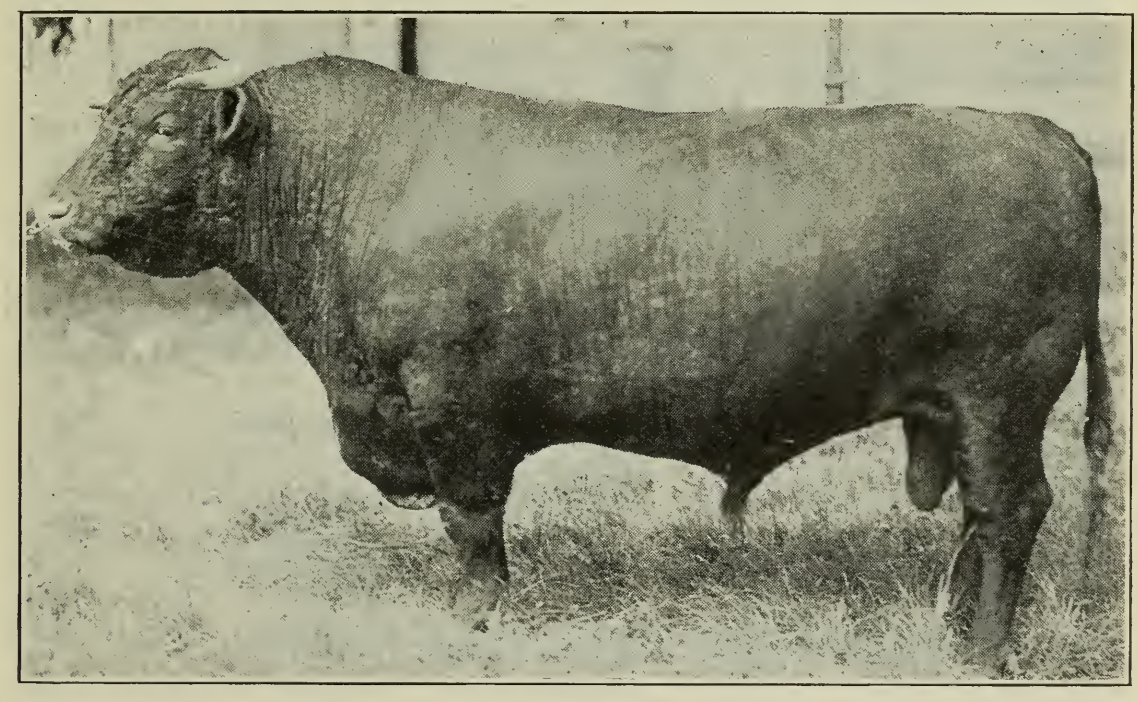
Following the Cruickshanks, who had done such wonderful work in the establishment of type, and working with foundations laid almost entirely by these pioneers in Scotch Shorthorns, came William Duthie, whose herd, founded in 1856, right up to the time of his death a short time ago, has been recognized the world over as the greatest modern herd of Shorthorn cattle. Mr. Duthie specialized in the production of sires and Duthie-bred bulls to-day head most of the leading herds in the home of the breed.

Shorthorn cattle are among the heaviest of the beef cattle breeds. In fact, they are often considered to be the heaviest breed, although they do not exceed the Hereford very much in weight. Mature breeding cows should weigh from 1,300 to 1,500 pounds and, of course, many are considerably heavier than this, some ranging as high as 1,700 and 1,800 pounds. A mature Shorthorn bull is considered under size if he does not weigh more than 1,800 pounds and many of the leading bulls of the breed weigh from 2,200 to 2,500 pounds.

Shorthorns may be red, white, or roan or any combination of these colours. Very light red is objected to, as is also a spotted intermingling of the three colours.

Many breeders also object to cattle showing white hind legs, although it is no disqualification, but is a marking that is often passed down generation after generation. Black should not occur and dark muzzles are decidedly objectionable. Dark red is always preferable to the light red and a dark roan is generally a little more in demand than a light roan. While some of the best animals of the breed have been white, buyers sometimes discriminate against this colour. There should be no reason for this discrimination for, in the history of the breed, some of the best breeding bulls and cows and many of the outstanding show-ring winners have been white in colour.

In conformation the Shorthorn should conform to the beef type showing a short, broad head, full, yet placid eye, and a fine, flat horn, preferably coming out straight from the poll then turning inward and slightly downward. The neck should be short, clean cut, and blended smoothly into the shoulders. Individuals of the breed are sometimes criticized for roughness of shoulder and



Browndale Banner, 123199.

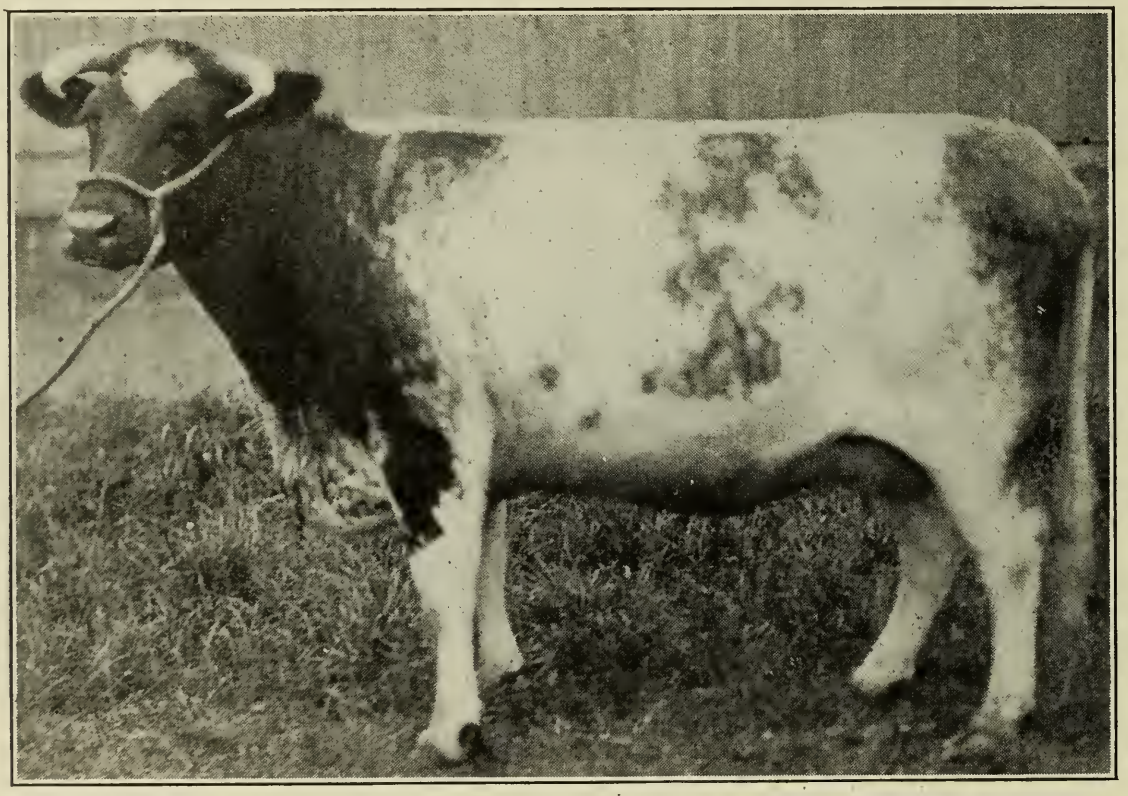
Senior Shorthorn herd sire at the O.A.C., and former champion at the Canadian National Exhibition. This bull is eight years old and weighs 2,300 lbs.

lack of heart girth. This being true, it is well to select animals with smooth well laid in shoulders and a great spring of rib giving a large heart girth. The back should be straight and strong with a broad, level loin carrying evenly into well set in hook bones. There is a tendency, in some Shorthorns, to be a little too prominent over the hooks, which makes them appear slightly rough. The quarter should be long, level and well filled and the thighs full and meated right down to the hocks. The underline should be straight and parallel with the top line, which means that the fore and rear flanks should be well let down. The entire body should be covered with a deep coat of mellow fleshing evenly laid on and the skin should be soft and pliable as an indication of quality. Most good Shorthorns carry an abundant coat of fine silky hair. Scotch breeders lay a good deal of emphasis on this point, always claiming that a thick mossy coat indicates good feeding qualities.

The Shorthorn is possibly the most popular beef breed of cattle known and

certainly stands first in favour in Ontario. It has also made great progress in the Argentine, South Africa and the United States as well as in the home of the breed. Records show that the breed was first introduced into Ontario about 1832, but the first cattle to be imported direct from the Old Land were brought out by George Miller, who came to York County, Ontario, bringing with him a few head in 1835. From that small beginning, steady growth took place in the Province until the breed is distributed throughout all the beef-producing counties.

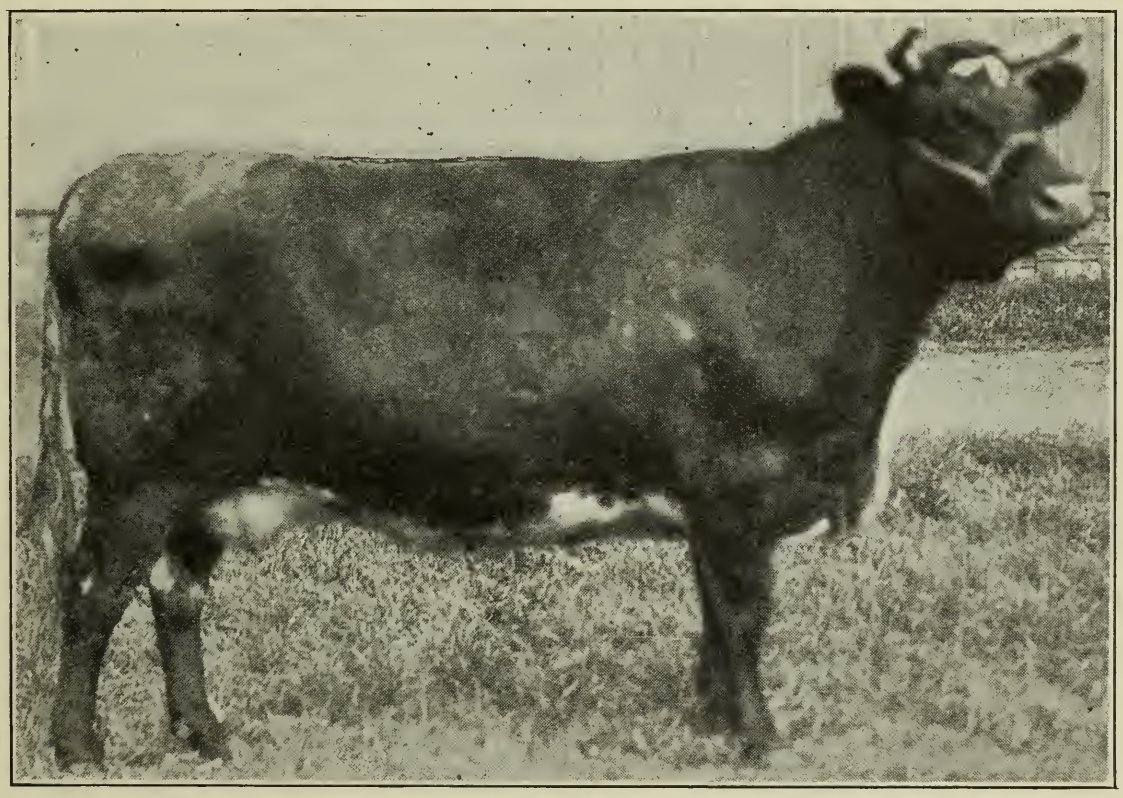
In the early days of the breed's history in this Province, cows were used for both beef and milk and consequently the Shorthorn became established as *the farmer's cow.* Later, the most popular strains from the standpoint of pedigree breeding and show-ring conformation were developed along beef-producing lines more than for milk production. This tendency was worked to such a degree that in the past few years an effort has been made by a number



College Augusta 8th, 148920.
Breeding Shorthorn cow, bred and owned by the O.A.C.

of breeders to increase the milk production of their cattle, and at the present time there are throughout the Province considerable numbers of breeders of dual-purpose Shorthorns, a branch of the breed in which milk production has been placed on an equal footing with beef production, if not, in some cases, held in higher esteem. The cattle that have been most prized as dual-purpose Shorthorns have been more of the old English type, not quite so low set as the Scotch cattle and not quite so pronounced in beef type. Breeders, however, have for the most part recognized that breed type must be preserved, and with few exceptions have endeavoured to retain the best possible beef type. It must also be remembered that a good Shorthorn cow, even of pronounced beef type, should at least give sufficient milk to raise her calf in a thrifty condition. Extremes are dangerous. A beef cow that will not milk can only be kept at a loss and a Shorthorn that cannot be made into reasonably good beef is not

worthy of the name. In the spring of 1913 the record of performance was opened to Shorthorn cattle and since that time a considerable number of Shorthorn cows have qualified in the R.O.P. with very creditable records. It is believed that the aim of the breeder of dual-purpose Shorthorns should be the production of about 8,000 pounds of milk without deteriorating to any appreciable extent the beef-producing qualities of the breed. Notwithstanding the fact that more interest is now being taken in dual-purpose Shorthorns in Ontario, by far the greatest percentage of Shorthorn cows are allowed to nurse their calves and greatest demand at public sales is usually found for the straight Scotch cattle as contrasted with the plainer-bred Scotch-topped or English types.



Rosewood 94th, 210603.
This 1,800 lb. cow is one of the good breeding matrons at the O.A.C.

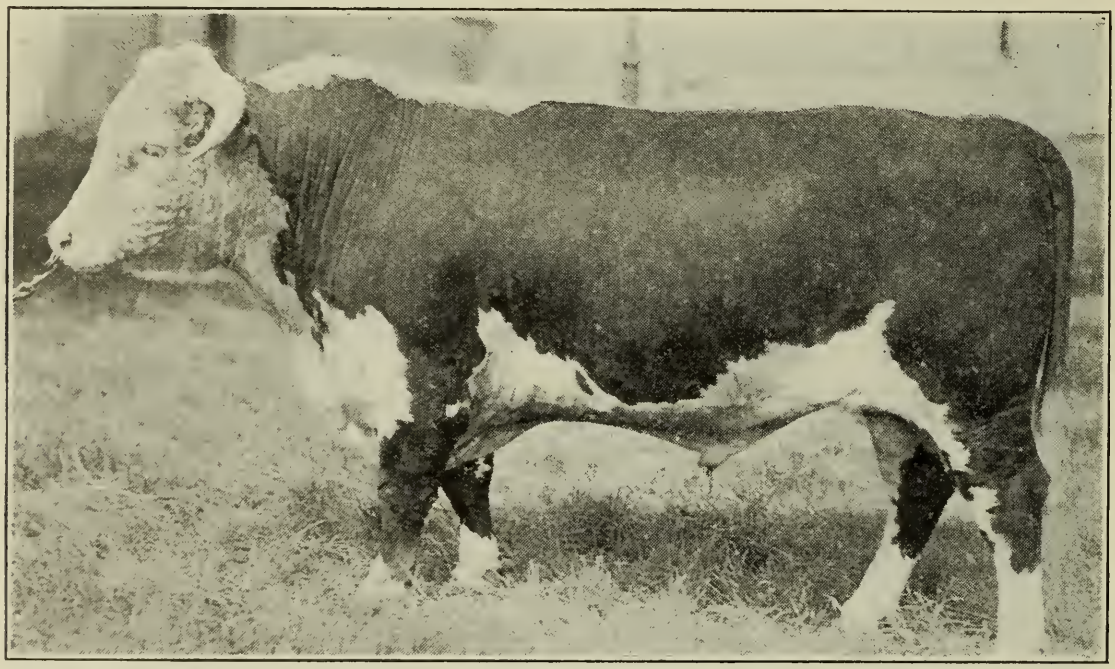
The Polled Shorthorn

A hornless breed known first as the Polled Durham and more recently as the Polled Shorthorn had its origin in the United States where some years ago native Mulley cows were bred to Shorthorn bulls. Later, what was known as double standard Polled Durham cattle were produced from the mating of pure-bred Shorthorns which were free from horns, a condition occasionally found among horned cattle and known in breeding terms as a sport. These hornless Shorthorns produced animals with true polled heads and, of course, from pure-bred Shorthorns, were eligible for registration in the Shorthorn herd books, whereas Polled Durhams produced through the Mulley cow cross were eligible only in the Polled Durham herd book. The breed is now known as the Polled Shorthorn and while it has a considerable distribution in the United States, has never made much headway in Ontario. The best type of the present-day Polled Shorthorn resembles in every particular good Scotch type cattle, only they have polled heads.

The Hereford

Hereford cattle had their origin in the county of Hereford, England, close to the Welsh boundary. Herefordshire is known as a great grazing county, rather rolling and even hilly in topography but producing an abundance of luxuriant pasture. The breed is one of the oldest recognized and while its origin is more or less obscure, it is known that late in the seventeenth century, certain white-faced cattle were imported from Holland and crossed on the native cattle of the district. At the same time, some claim that the real foundation of the breed was a certain white-faced bull brought into the district from the Tees Shorthorn country about 1760. In the early days of the breed, several colours were recognized, among them being light grey, dark grey and red with white faces, while some others had mottled faces.

Perhaps most credit for the early development of the breed should go to the Tompkins family. Richard Tompkins, at his death in 1723, left some



Willowsprings Gay Lad 95th, 41308.

Hereford herd sire at the O.A.C., and a big prize winner as a yearling. Photo at three years old. This bull at 4 years old weighs 2,300 lbs.

cattle of Hereford type to his son Benjamin, who, in turn, at his death in 1789, left to his son of the same name a considerable herd. This latter Benjamin, by a practice of close in-and-in breeding, was able to produce a much smoother, earlier maturing, higher quality class of cattle than had previously been bred. After his death, in 1815, the entire herd was sold at auction in 1819.

Prominent in the work along with the elder Benjamin Tompkins was Wm. Galliers, who was born in 1713 and who died in 1771 and who used practically the same foundation blood as that used in the Tompkins herd.

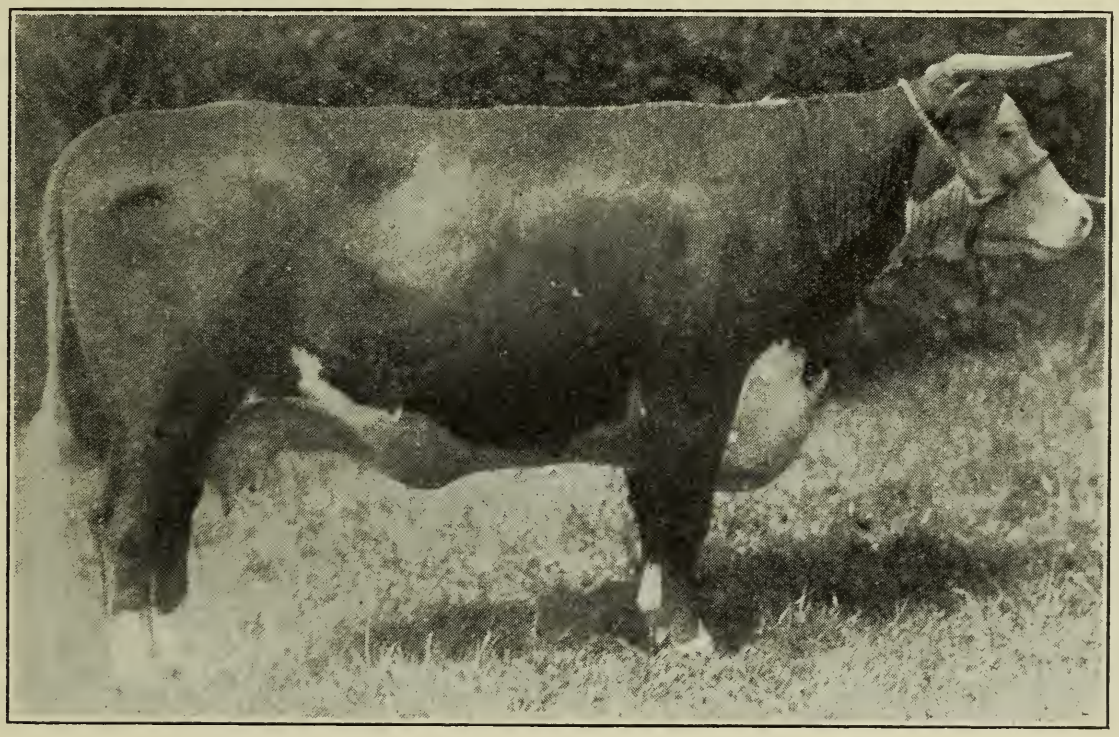
Following the younger Tompkins came John Price, who also practised, in his breeding work, the closest possible concentration of blood and produced cattle of great scale with a wonderful spring of rib and depth of fore quarters and considerably more quality in the hind quarters than had been common to the breed. Price worked great improvement in the breed and his cattle were in demand right up to the time of his death in 1841.

Mention should also be made of John Hewer, born in 1787, and who was

prominent in the breeding of Hereford cattle until his death in 1873. It is said that present-day strains of cattle almost invariably trace to Hewer's stock.

Working along with Price and Hewer was Thomas Jeffries, Jr., a scion of a family that had been breeding Herefords for a number of years. By a liberal infusion of the blood from the Hewer herd, Jeffries succeeded in making great progress in the improvement of the breed.

Hereford cattle are widely distributed wherever beef raising is a prominent branch of agriculture. The breed has found great favour in sections of various countries devoted to grazing. Herefords are good range cattle, very hardy and thrifty. The breed has become popular in the United States, in the Argentine, and in Western Canada, and while it is fairly liberally sprinkled over Ontario, has not gained the prominence in this Province that one would have expected. The breed had its introduction to America in 1817 when four head



Miss Brae 94th, 613829.
A former champion Hereford cow, one of the good ones in the O.A.C. herd.

were taken to Lexington, Kentucky by the late Henry Clay. Frequent importations of Herefords to the United States were made between 1840 and 1860, and in the latter year F. W. Stone of Guelph, Ontario, Canada, began importing Herefords and became the largest breeder of Herefords on the American continent.

Great advancement has been made in the breed in the United States, where several outstanding families have been developed through the use of some outstanding bulls. These families have been developed largely from two lines of breeding, namely, the Anxiety strain, descendants of Anxiety IV, and the Garfield strain, descendants of the bull called Garfield. The leading families developed have been: Anxiety, Garfield, Beau Donald, Prime Lad, Fairfax, Perfection, March On, Hesiod, Disturber, Corrector, Princeps, Bonnie Brae, Repeater, Gay Lad, Woodford, Albany and many combinations of blood resulting from crosses of these strains.

The Hereford compares favourably with the Shorthorn in size and females

of the breed should weigh from 1,300 to 1,500 pounds or more, with males from 1,800 to 2,200 pounds and even up to 2,500 pounds. The colour of the Hereford is a distinguishing feature with the body a cherry red and the face, head, top of neck and brisket generally white. The white markings generally extend well down the back and the underline is also generally white, as is also the switch and usually some white is found on the legs below the knee and hock. A light yellowish red or an unduly dark red may be frequently found, but is not as desirable a colour as a bright cherry red.

Herefords should conform closely to beef type. They are cattle with great constitutions, good middles and wonderful fronts. They are noted for their short, broad heads, strong muzzles, showing great feeding capacity. The horns should be flat and fine and preferably should turn inward and downward. The neck is short and thick and the shoulders usually very smooth, but the breed has a tendency toward an over development of dewlap and brisket. The Hereford shows a great spring of rib, strong heart girth and good middle, but has a tendency to run a little light in the hind quarter. The best specimens of the breed, however, are straight on top, broad over the loin, smooth at the hook bones and reasonably well filled between hooks and pins as well as being low in the twist and thick through the thighs. Good Herefords are very fleshy animals and the meat should be laid on smoothly and evenly. Their hides usually run a little heavier than those of the Shorthorn, but the skin should be soft, pliable and mellow. Hereford cattle usually have plenty of bone. No breed excels the Hereford in beef type from hook bones forward, and breeders have made wonderful improvement in smoothness over the hind quarters of their cattle.

The Polled Hereford

Polled Herefords were originated in the Province of Ontario and were first bred by Mossom Boyd near Bobcaygeon, who used in the making of the breed Aberdeen Angus bulls on pure-bred Hereford cows. Later, a somewhat similar type of cattle was developed in the State of Iowa by using a red Polled bull on Hereford cows. Some time later a breeder named Guthrie located a few Polled females amongst pure-bred Herefords and these formed the foundation of pure-bred Polled Hereford blood. No other strain of Polled Herefords is now recognized but that developed from pure-bred Polled Herefords. The breed is widely distributed in the United States and a few herds are to be found in Western Canada, but it has never made any progress in the Province of Ontario.

The Aberdeen Angus

The Aberdeen Angus breed was first developed in the counties of Aberdeen, Kincardine, Forfar and Banff, Scotland. In Aberdeen, particularly in the Buchan district, the breed was first known as Buchan Humlies, while in a section of Forfar, commonly called Angus, the breed was known as Angus Doddies. The real origin of the breed is not known. There were hornless cattle common to the district in the very early days and some writers claim that the breed had its origin in a sport from the black-horned cattle formerly common to the district in which they have been developed. Hornless cattle have been known in Scotland for well over a century and it is more than likely that the breed was really started from some of these polled cattle, freaks in the horned breed.

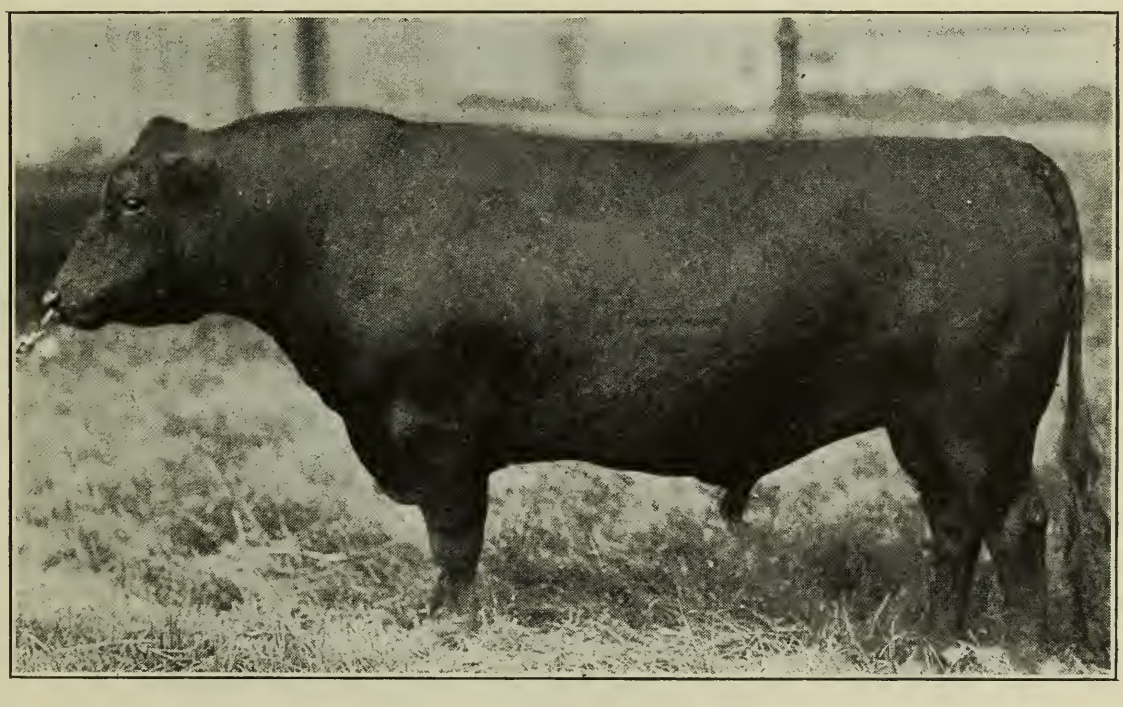
In the development of the breed, Hugh Watson of the County of Forfar was the first great improver. He was born in 1789 and continued to work with his cattle until the time of his death in 1865. His herd was built up from

a half dozen cows and a sire, specially selected and in the improvement of his herd he practised a good deal of in-and-in breeding. His most famous cow, Old Granny, lived to be thirty-six years old and produced twenty-five calves.

Watson's work was followed by that of Wm. McCombie, who was born in Aberdeenshire in 1805 and began breeding Angus cattle in 1830. McCombie put great stress on the sires he selected. He was a believer in individual merit as well as pedigree. He developed the great Queen Mother family from a cow called Queen Mother (348) which he purchased from Wm. Fullerton and from whose line he bred Pride of Aberdeen (581), the founder of the Pride family.

Working at the same time as McCombie, Wm. Fullerton founded a herd in 1833 and met with considerable success. He bred the cow Queen Mother, the foundation of the Queen Mother or Queen family.

Of the more modern breeders of Angus cattle who have done a good deal toward the improvement of the breed, Sir George Macpherson Grant of Ballin



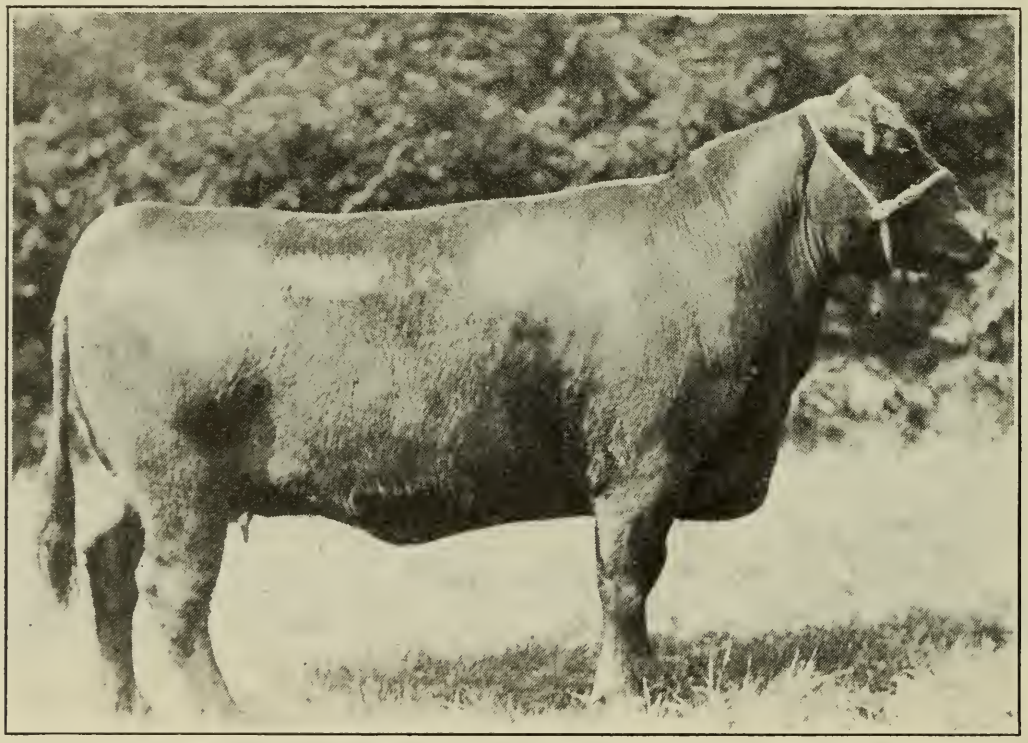
Elm Park Elford, 24387.

Aberdeen Angus herd sire at the O.A.C., a prize winner himself and a sire of winners. This bull is a little undersized, weighing 1,800 lbs., but is very smooth and of excellent type.

dalloch stands out in front, and the Ballindalloch herd has produced a large number of really outstanding cows. The Erica tribe with its many branches had its beginning in this herd, as well as such families as Coquette, Jilts and many others.

The breed was first introduced into America in 1873 and the first Angus to come to Canada were brought to the Ontario Agricultural College in 1876. Aberdeen Angus cattle have made more progress in the middle Western States than they have in Ontario, but from their first entry into this province they have held their own against other breeds in the production of beef and have always stood in high favour with butchers because of their smoothness, quality, and reputed high percentage of edible, lean meat. The breed is spread throughout Canada over all provinces and is bred and fed as a specialized beef breed. The calves make excellent baby beef and some prize Angus bulls for crossing on Shorthorn cows in the production of high-class, early maturing beef. Angus

cattle are fair grazers and are particularly well suited to loose-box feeding. While in the beginning only a few families were famous, such as the old Queen Mother and the Pride of Aberdeen and the Lady Ida, many new strains are now recognized. In the United States the various branches of the Erica family are very much prized. This family, of course, had its origin at Ballindalloch and several strains of Ericas, such as Eisa, Enchantress, and Elba Ericas, have been developed, as well as the branches of the family named after the bulls, Trojan, Kildonan and Chieftain. In the United States, also, a number of different lines of a family called Blackbird have been developed from the Old Lady Ida family, and from the Blackbirds again came the Blackcaps. In fact, the Ericas, Blackbirds and Blackcaps are more prized blood lines in the United States than are the Pride of Aberdeen and Queen Mother tribes. Other recognized families are McHenry Barbara, Coquette, Heatherbloom, Beauty of Portlethen, Jilt, Favourite, Zara, Westertown Rose, Mina, Nosegay and Victoria.



College Maid, 20675.
Angus cow, bred and owned by the O.A.C. A good type of breeding matron.

Aberdeen Angus cattle are black and should be almost solid black, very little, if any, white being found on a high-class pure-bred Angus. Occasionally a little white is seen on underline or udder of cows, and on rare occasions a red calf is dropped. Red males or those with any degree of white above the underline or on the legs are not eligible for registration. Bulls should weigh from 1,800 to 2,200 pounds or more and cows from 1,200 to 1,500 pounds. The Aberdeen Angus of best type represents the butcher's ideal of a beef animal. Angus cattle are very low set, deep and exceedingly smooth. The head is clean cut, short and broad, with a sharp, distinct poll. The neck is short and the shoulder veins well filled. There is a tendency in Angus cattle toward roughness of shoulder, but this is not found in the best specimens. A great spring of fore ribs, a straight, strong top, extreme smoothness over the hooks and between hook and pin bones and a more or less cylindrical spring of rib are characteristic of the breed. Angus cattle should be low in the twist, full in the

thighs and should show fine quality of bone, extreme evenness and smoothness of fleshing with a soft, pliable skin and a thick coat of hair. Aberdeen Angus cattle or their crosses have won more carcass competitions than any other breed of beef cattle. The cows, however, are rather light milkers, due no doubt to the extreme beef tendency of the breed.

MINOR BEEF BREEDS

The Galloway

Galloway cattle were developed as a breed in the counties of Wigton, Kirkcudbright and parts of Ayr and Dumfries, where, for many centuries, hornless beef cattle have been common to the district. Some breeders claim that Galloway cattle always showed true polled character. Others believe that the breed descended from polled wild cattle. Early breeders who did much to improve the Galloway chiefly by selection rather than by in-breeding were Murray of Broughton, Craik, Dalyell, Herring, the Gordons of Greenlaw, the Earl of Galloway and many others. Most of the early improvement was done in the eighteenth century. Galloway cattle have always stood high in the beef competitions of the Smithfield Show in the Old Country.

The breed was first introduced into Ontario in 1853 by Graham Brothers of York County, and in 1861, Thos. McCrae of Guelph, another pioneer, made his first importation. Comparatively speaking, the breed has not made headway in Canada and in recent years has lost ground in the Province of Ontario. In size, Galloway cattle are a little smaller than the Angus. The polled character is distinct. The head is short and broad, but does not show as sharp a poll as does the Angus and the whole body is covered with a coat of thick, long, slightly curly hair which serves to distinguish the breed from the Angus. While the Galloway is set on short legs it does not show the spring of rib that the Aberdeen Angus does, is flatter on the rib and generally longer in the body, although the body is somewhat cylindrical as with the Angus. Strength of top, straightness of underline, depth and thickness as generally found in the beef type are all desirable and the breed is noted for length and fullness of hind quarter. Sometimes a brownish or reddish tint is noticed in the colour, but white markings are a disqualification.

Galloway cattle are very hardy, good grazers, and producers of a high quality of meat. Cows are not noted for heavy milk production, but in the matter of prepotency and fecundity the breed stands well to the fore. Owing to the thick coat of hair, Galloway hides are valued for the production of rugs and robes. The breed is not widely distributed outside of Scotland and the United States. Comparatively few herds are found in Canada, where breeders have criticized the breed on its slow maturing nature and tendency to flatness of rib, weakness of top, and lack of feeding qualities. It may be said, however, that the best type of Galloway is a fairly good animal from the standpoint of the producer of beef.

The West Highland

The West Highland breed of cattle originated in the hill country of Western Scotland and is one of the oldest breeds. In colour, West Highland cattle may be black, brindle, yellowish red, or a mixture of red and black. In size, they are rather small, 1,200 pounds being considered a fair weight for a mature bull. The head is very bold and carries long, graceful horns which, with the coat of long, curly hair make a very attractive front. The neck is short and thick

and the animal very low set, broad, deep and thick throughout. West Highland cattle are rather small, cows averaging about 900 pounds and bulls about 1,200 pounds.

Other Breeds

There are three other breeds that might be mentioned in a discussion of beef cattle, namely, the Red Polled, Devon and Brown Swiss, but as these are generally considered dual-purpose breeds we are discussing them in a dairy cattle bulletin rather than with the beef cattle. None of these three breeds has taken a prominent place in Ontario. There was a time when there were a considerable number of Devon cattle in the Province, but they were not big enough to increase in popularity. The Red Polled breed has found some favour in Western Canada but has not increased in Ontario, while the Brown Swiss has never become firmly established in this Province.

BREEDING METHODS

In all live stock work, breeding methods are at the foundation. Success cannot follow, even with the best of feeding, unless care in breeding has been practised. There are three systems commonly used by the average man in an effort to maintain and improve his beef cattle, and these are: pure-breeding, grading and crossing, and it is well that we discuss these methods.

Pure-breeding

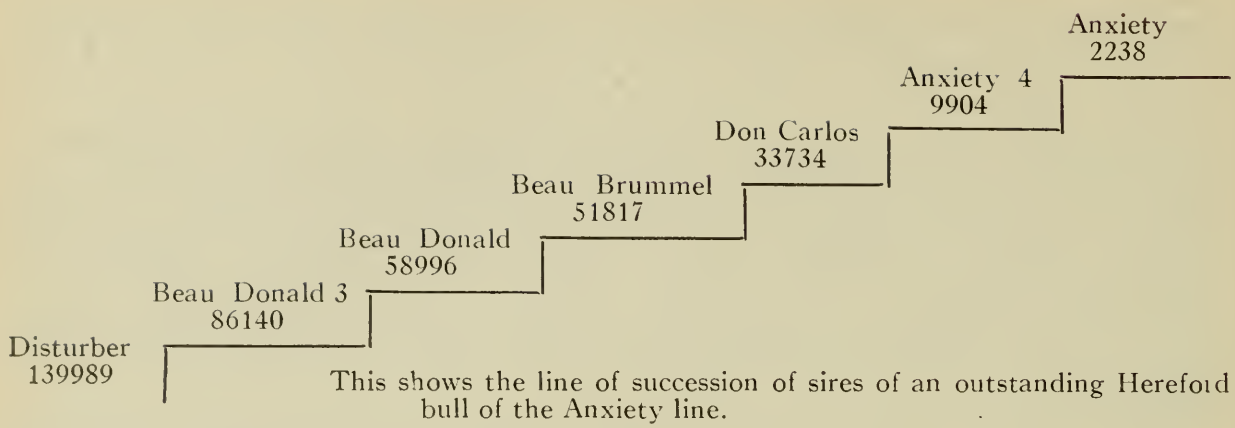
Most advanced forms of breeding are found among the systems followed by breeders of pure-bred stock who are striving to improve the breed they are working with. A pure-bred is an animal with no unimproved blood, and for matters of record pedigrees are given to these pure-bred animals. A pedigree is simply a history of the animal's ancestry as to blood lines. Perhaps the various methods followed for close concentration of blood lines are as prominent in beef cattle breeding as in the breeding of any other class of stock. Breeders of pure-breds who have outstanding herds are forced to stick to a close concentration of blood, but perhaps the most favoured system is the selection of pure-bred sires and females not closely related one to the other. Most of our breeders of ordinary herds of pure-bred cattle prefer to use a sire not too closely related to the females, believing that line-breeding and in-breeding are rather dangerous practices, except in the hands of very experienced breeders who have outstanding herds for which it is difficult to find, outside of the blood lines represented in the herd, sires of sufficient excellence to ensure improvement. It is a law in breeding that unless the sire is an improvement on the females in the herd he can do no good and is likely to work harm. Breeders in outstanding herds follow either one of two systems in their pure-bred work relying for improvement on line breeding or in-breeding. The latter is simply the first mentioned carried to the extreme. We generally speak of line breeding as the mating of animals that in blood relationship are no closer than cousins. So far as beef cattle are concerned it is the mating of a bull and female of similar blood lines but not closer than cousins, whereas in-breeding may consist of the mating of animals that are very closely related such as sire and daughter, mother and son, brother and sister, and half-brother and half-sister.

It will be noted, then, that in line breeding the breeder selects males and females of the same line of descent. Pedigrees of both show very similar blood lines and it must be said that line breeding has done a good deal for the

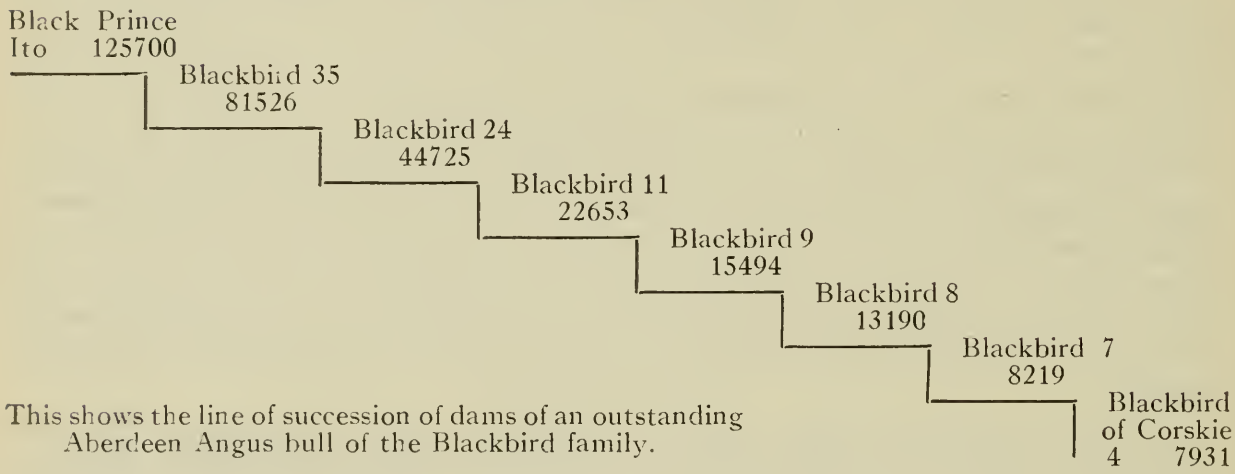
improvement of our breeds. It brings out the strongest hereditary influence, but can only be practised where the breeder is careful to select animals of outstanding individuality as well as strong pedigrees. The danger is that the inexperienced breeder may pay more attention to pedigree than to individuality and, if he does, the concentration of blood is liable to bring out all the weak points of the inferior individual selected. Line breeding is the safest, quickest and best system of improvement but can only be practised successfully by experienced breeders. The beginner should avoid the system and should stick to the safer plan of mating animals that are not closely related until he has developed a strong herd and has become thoroughly conversant with breeding problems.

Line breeding carried to great length involves the mating of animals even more closely related. The tendency is, after having met with some success in line breeding, to carry the practice on to in-breeding or in-and-in breeding. The breeder hopes to so concentrate the blood as to bring out the most desirable qualities of his stock, and while it is true that this close concentration may bring out these desirable qualities, it is also true that any defects peculiar to animals with the blood lines represented are liable to crop out, and in-breeding should not be practised by any outside of a few of the outstanding breeders and it is always more or less of a dangerous practice which, if carried too far, will injure the vigour, virility and fecundity of the herd. In-breeding is not a safe practice for the beginner and should be used only to a limited extent by the older, experienced breeders.

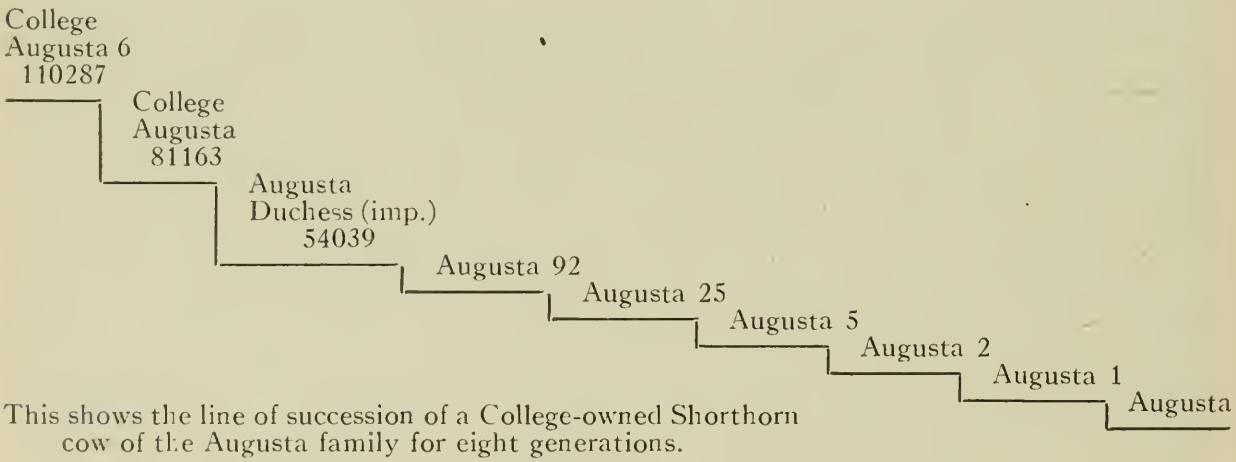
In the discussion of the various breeds we have mentioned the more important families as recognized by breeders of these pure-bred cattle. It should be pointed out here that, while it may be a fad or a fancy to lay stress on certain so-called families in the various breeds, the breeder of pure-bred cattle, if he is going to make headway in his herd, must pay some attention to family, which, after all, means blood lines. So-called plain-bred pure-breds rarely meet with ready sale, and in the three breeds, Shorthorn, Hereford and Aberdeen Angus, which are commonly bred in the Province of Ontario, pure-bred breeders can only make progress by paying attention to family lines. In the discussion of these breeds the outstanding families are named and it is well that the breeder understand how families are shown in pedigrees. In the Shorthorn and in the Aberdeen Angus the families are named through the breeding line on the dam's side of the pedigree, whereas in the Hereford, the families are named from the breeding lines on the sire's side of the pedigree. There is, of course, a weakness in both systems. In Shorthorn and Angus cattle it is important that the animal should be attached to some family as shown by the dam's side of the pedigree, but it is equally important that the top bulls in the pedigrees are themselves outstanding bulls of a distinct line of breeding. In Herefords, it is well to see to it that besides having a number of outstanding bulls in the pedigree, that the cows represented are of the right kind of breeding and blood lines. The following will show from three actual pedigrees, extended in part, how family lines are determined in the three leading beef breeds in this Province.



This shows the line of succession of sires of an outstanding Hereford bull of the Anxiety line.



This shows the line of succession of dams of an outstanding Aberdeen Angus bull of the Blackbird family.



This shows the line of succession of a College-owned Shorthorn cow of the Augusta family for eight generations.

In studying the line of descent shown in the three parts of pedigrees here used for illustration the reader will notice that the Hereford bull Disturber shows a direct line of descent from the bull Anxiety IV, which was the founder of the Anxiety family. Sires, in each generation, are all that are shown and it is from the sire that the family is named.

The bull, Black Prince Ito, is given as a typical Angus of the Blackbird family. The dams only are named for seven generations going back to the foundation cow of one of the branches of the Blackbird family.

With the cow College Augusta 6, it will be noticed that the same system is followed as with the Angus, namely, that the dam's side of the pedigree is all that is given and is all that is used in naming family. It is quite obvious that other things besides family should be considered and there are many lines of breeding shown in the average tabulated pedigree besides those depicted by either the sire or the dam line alone. In Shorthorns and Angus the top sires

are important, and in Herefords the breeding of the dam should be studied. Nevertheless, while the methods of naming families in all breeds are far from perfect, it is well, if one is going into the pure-bred business, to give some consideration to family, because, in most instances, these families have been developed from outstanding families and strains and have some merit over and above the average conglomeration of blood.

Grading.—While we have spent a good deal of time in a consideration of pure breeding, we must recognize the fact that improvement in commercial live stock is generally started by the grading-up process which means the mating of a common, unimproved female with a pure-bred sire and this followed generation after generation with pure-bred sires of the same breed. The average man makes more rapid progress from inferior scrubs to market selects by using this method than by any other known system. The unimproved blood gradually disappears as shown by the following table and chart:

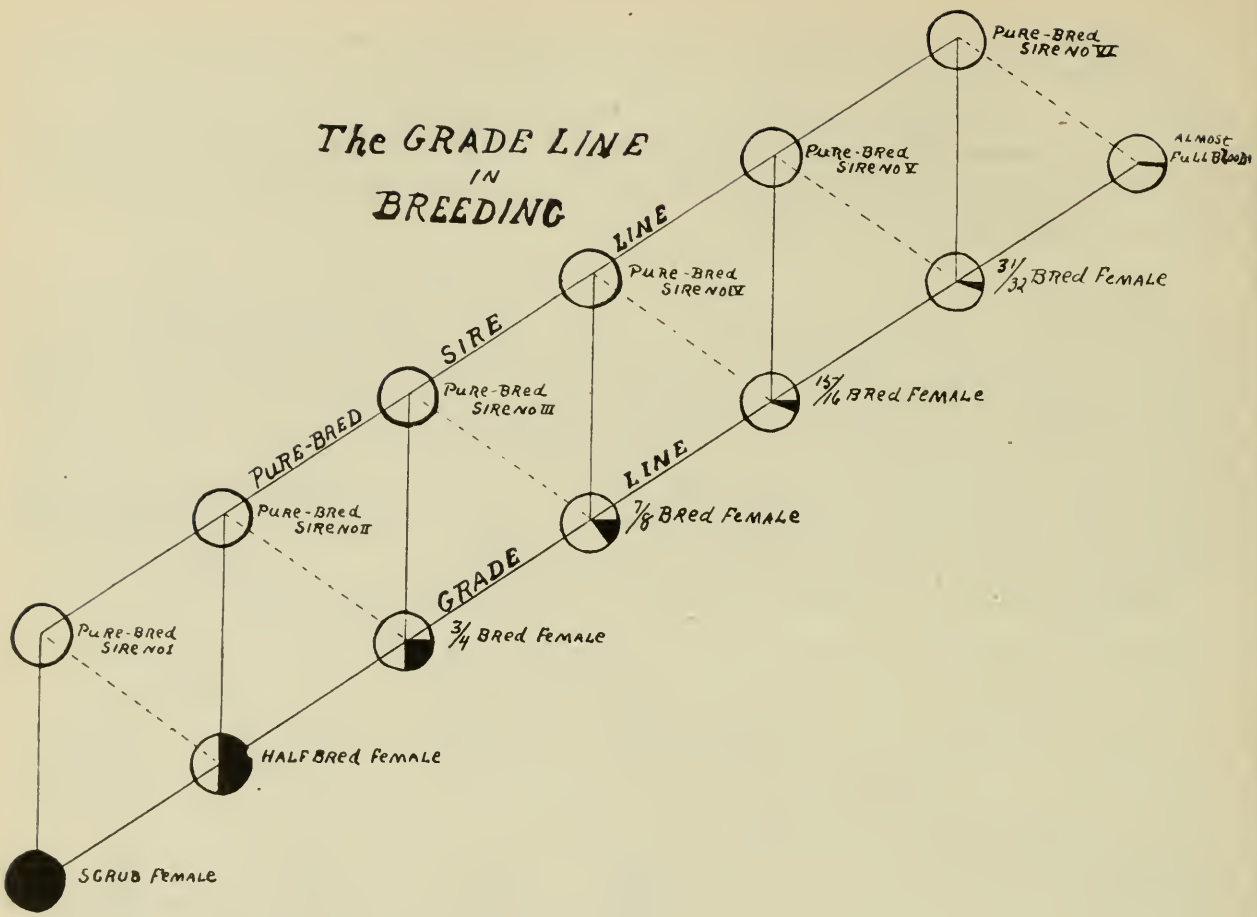
Disappearance of unimproved blood in using pure-bred sires.

Generations	Sires per cent. of purity	Dams per cent. of purity	Offspring	
			Per cent. of purity	Per cent. of unimproved
1	100	0	50	50
2	100	50	75	25
3	100	75	87.5	12.5
4	100	87.5	93.75	6.25
5	100	93.75	96.87	3.12
6	100	96.87	98.44	1.5

The Grade Line in Breeding

No other method of animal improvement works as fast progress as does grading up. The accompanying illustration shows clearly what happens. By mating the pure-bred bull No. 1 with the scrub female, we get the half-bred female. By mating this half-bred female with pure-bred bull No. 2 of the same breeding as pure-bred bull No. 1, we get the three-quarter bred female, and so on to the sixth generation where the unimproved blood is almost entirely eliminated. The black represents the unimproved blood in the females. Notice how it disappears, generation after generation by the use of a pure-bred sire. Assuming that the cow and the bull each exert the same influence on the offspring, look how the grade line goes up and up toward the pure. We have put in a sire line also, because we believe that better pure-bred sires should be used generation after generation.

Grading has done more for the herd than any other one thing, but it cannot add anything to breed and can only be relied upon where pure-bred sires of good type are used to the exclusion of all others. The use of graded-up sires is entirely unsafe and generally marks a step backwards. Grading-up is the best system for the beginner in beef cattle breeding. It is the most economical system for starting in beef cattle and the rapid progress that is possible where good pure-bred sires are used generation after generation makes this system the favourite with breeders who are engaged in the commercial production of beef. It only requires five or six generations of the use of pure-bred sires to make the herd practically pure-bred although not eligible for registration.



Crossing.—Cross breeding has, in the past, been a fruitful source of the production of new types and breeds. It simply means the crossing of a pure-bred sire of one breed on pure-bred or well-graded-up females of another distinct breed. It may produce first-class animals in the first generation, and there is a belief amongst feeders that crossing tends toward the production of better feeding stock. We find this idea prevalent amongst some steer feeders, who insist that an Aberdeen Angus bull used on high-grade Shorthorn cows will produce steers that make cheaper and more rapid gains and suit the market better than steers from either breed bred pure or practically so. Crossing may have some value in the production of commercial stock if it is not carried beyond the first generation and if no attempt is made to blend types in a violent cross, such as using an Aberdeen Angus bull, for instance, on Holstein cows. Crossing is generally considered a dangerous practice to recommend, because the average man is likely to keep, for breeding purposes, some of the females resulting from his crossing effort and, generally speaking, where this is practised, results are disappointing. It may add vigour to the first generation, but if persisted in further will result in a motley aggregation of nondescript cattle.

Some Common Terms and Beliefs.—Progress in breeding is based on the law of variation. The breeder knows that no two animals are exactly alike, but that like tends to produce like. Keeping these two facts in mind, it is through selection that the breeder makes progress and from practice he learns that the closer he selects to a set type the less will be the variation in animals produced. Experience also teaches that the chances of variation from type decrease with each generation bred from pure-bred sires of similar breeding and conformation. It is believed that an animal inherits fifty per cent. of what it is from each parent, twenty-five per cent. from each grandparent, 12.5 per cent.

from each great grandparent, 6.25 per cent. from each great, great grandparent, and so on in proportion. It will be seen from this that the influence back of five or six generations is not likely to have very much effect upon an individual animal, so that it is necessary to pay more attention to the breeding and individuality of the animals close up in the pedigree than to go too far back into ancient history, and yet the breeder must remember that the individual animal represents some possible combination of all that has gone before, and that reversion to a former ancestor is possible; therefore we find, from time to time, off type, coarse animals appearing even in the best herds as a direct result of reversion or atavism, which simply means a throwing back to some former types. Thus we find an occasional Aberdeen Angus coming red in colour and an occasional Hereford showing a yellowish red with a line back and an occasional Shorthorn with a black nose. Some breeders believe that these off colours and certain off types are due to maternal impressions, but not so. Some will say that one should be careful at the time of service that the dam does not see cattle of another colour, but there is no experimental evidence to prove that there is anything in these notions regarding such maternal impressions.

There is, in breeding work, a tendency also for freaks or sports or mutants to appear. While like generally tends to produce like, occasional freaks with little or no distinct resemblance to the breed from which they come occur. For instance, polled cattle have been produced from horned sires and dams whose ancestry were horned for many generations. This is termed by students of breeding a sport or mutant. New breeds have had their origin from such mutants.

There is a belief, which still exists among some practical men, that offspring may be influenced by a previous impregnation. Such breeders will tell you that a pure-bred Hereford cow, for instance, if mated with a pure-bred Angus bull is liable to be ruined for future pure breeding, or that future calves may, even though they are by a pure-bred Hereford bull, show some Angus characteristics. There is no real experimental evidence to show that such is the case, and there is plenty of evidence that it is not according to facts, so that telegony or the influence of a previous impregnation on future offspring is not accepted by students of breeding.

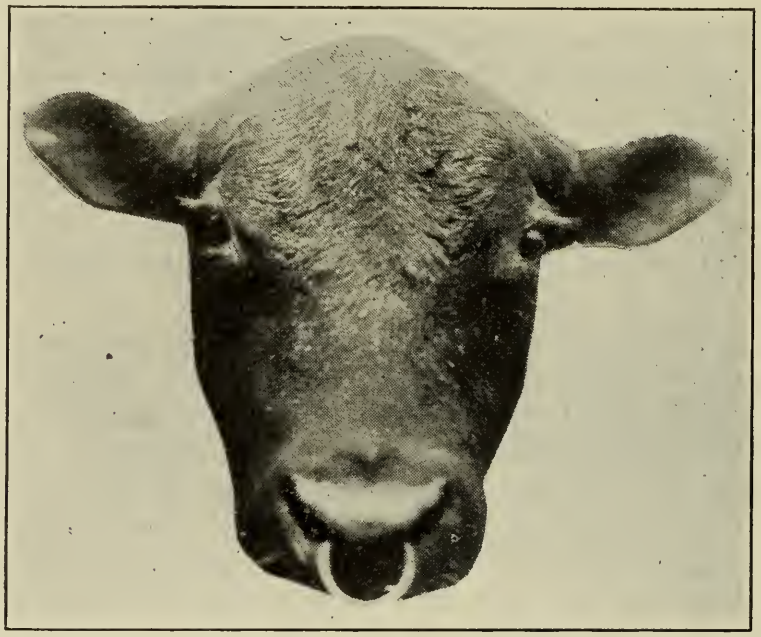
The conditions under which animals are reared may have some effect upon future type and characteristics, but, as a general thing, acquired characters are not inherited. At the same time, surrounding conditions of feed and care, while they may not cause variation, are limiting factors in all development. Persistent overfeeding with accompanying lack of exercise almost invariably proves injurious, and certain animals in a herd so cared for are almost sure to become shy or non-breeders. Persistent underfeeding, bordering on starvation, has a similar tendency.

It will be seen from the foregoing paragraphs that all progress in breeding to improve the herd is made through selection. In the wild state, natural selection, which meant the survival of the fittest, insured vitality. Only the stronger male animals survived the fight to be head of the herd and only the stronger females fought off successfully the inroads made by preying beasts, disease, scarcity of feed and other causes. In the domesticated state, the selection must be made by the owner of the herd, and where it is not properly practised and controlled the herd is liable to deteriorate rather than improve. In the selection of breeding stock the breeder must choose animals of a fixed type and must endeavour, in so far as possible, to eliminate all undesirable variations from that type. It will be readily understood that the greatest

possible care must be taken in the selection of the sires used. The sire, if he is a good one, is at least half the herd. If he is an inferior animal he may be all of it.

Selection, Care and Management of the Sire

Whether the breeder is interested in the breeding of pure-bred cattle or is in the business on a commercial scale, no other factor is more important than the class of bull used and the care he gets. One of the big mistakes in breeding is the use of sires not showing the proper amount of breeding and quality for the herd with which they are mated. The better the pure-bred herd the more exacting must the owner be in his selection and, even for commercial beef production, no bull that is not of good breed and excellent beef type, properly backed by pedigree, should be used. The sire should show masculinity and breed character, for his influence is shown in the offspring of every female in the herd. He should be low-set, deep, thick and blocky, with a short, broad



A Beef-type Head.
Head of Elm Park Elford, O.A.C. Angus herd bull.
Note masculinity and breed character.

head, a short, thickly filled neck, smooth shoulder, straight and strong top line, great spread and depth of rib, good middle, strong, full loin, long, level quarters well filled in the round, and low at fore and rear flanks, giving him a straight underline. His whole body should be covered with an even, mellow fleshing, and an abundance of fine, silky hair and a pliable skin denote good doing qualities. The bone should be of fine quality but sufficient to carry the weight of the animal. It is generally advisable to select a bull of medium size and smooth rather than an over-sized, rough bull or a pony-type bull of quality, but under-sized.

The age of the sire is of some importance. Too many pin their faith to the young and untried bull, passing up golden opportunities of getting older and proven sires at reasonable prices. An older bull is to be preferred to a calf every time, if he is still active and sure. The tried and proven sire is invariably the safest selection, if one is available, and yet many choice three, four and five-year old bulls are allowed to go to the stockyards for slaughter, while people

take a chance on calves and yearlings for their next calf crop. Some system of exchanging these good older bulls through community effort would prolong the period of usefulness of many of our better bulls and would work for the good of the beef cattle industry.

If it is necessary to buy a young bull, he should not be put to use until at least fourteen or fifteen months old. Avoid, if possible, buying nursing calves. They generally look their best when full of whole milk and carrying an abundance of calf fat. If the young bull is attractive at fifteen to twenty months of age, it is likely there is something good about him. Two-year-olds are more valuable for breeding purposes than yearlings. Starting with a young bull between the age of fifteen and eighteen months, the breeder should be careful not to overdo him. Twenty-five or thirty cows may be enough for the first season, although many bulls are required to serve fifty to eighty cows in the first year. This may prove injurious to the future virility of the bull. A two-year-old or older will successfully handle fifty to eighty cows, if well cared for, but should be used only as a single service per cow and usually not more than one cow per day although, in the height of the breeding season, it may be necessary to breed a cow in the morning and another in the evening.

As a general thing for Ontario conditions, it is better to stable the bull than to allow him to run with the cows at pasture. Of course, for those areas where range conditions prevail, bulls must run with the herd, and under such practice the owner has the minimum control of his sires and breeding operations generally.

To ensure the best results in breeding, two things are necessary—exercise and judicious feeding. To supply the former, the bull should run loose in a roomy box-stall and should have at least five hours out of every twenty-four in an open yard or paddock. At the O.A.C. the stock bulls maintained are out in a large paddock all night when the weather is fit throughout the summer and are kept in their box stalls away from the flies during the day. In winter, these bulls have the full afternoon in the paddock each fine day and are kept in at night. Such exercise makes for vigour and consequent success in breeding. Sometimes an old bull, particularly one that is fat, becomes lazy. We have found it necessary, occasionally, to force such a bull to take exercise by leading or driving him up and down the lane. A more useful method might be to make him work a tread power as some breeders do. We have brought back a very irregular breeder to comparative success by forced exercise.

All breeding bulls should be kept in good condition, not overfat but in good health and thriving. Starving the herd sire is bad business. Too much heavy, heating feed should be avoided. Alfalfa or red clover hay, silage in limited quantity, roots, oats and a little barley with bran, and possibly, for thin bulls, a little oilcake, should form the basis of the winter ration. In summer, green feed, including alfalfa, red clover or peas and oats, and later in the season, corn, may take the place of hay, silage and roots, although at the O.A.C. the bulls get some silage practically the year round. A little care is necessary in feeding silage to breeding bulls. Too heavy feeding on this feed causes undue paunchiness and slowness in service. With our three more mature herd sires at the College, including an aged Shorthorn bull weighing 2,300 pounds, a four-year-old Hereford bull weighing 2,300 pounds and an 1,800-pound five-year-old Aberdeen Angus bull, the average winter grain ration runs from four and one-half to six pounds per day along with silage and roots mixed, equal parts by weight forty-five pounds, and hay from ten to twelve pounds. The grain ration consists of barley and oats mixed four parts and bran one part. If we find a bull getting paunchy

we increase the roots to thirty pounds per day and cut down the silage to fifteen pounds per day. If a bull is low in condition, one pound of oilcake meal is added to the ration until he picks up to normal. We find that younger bulls consume almost as much feed in order to make proper growth. With feeding on this basis we find that it costs about $84 per bull per year for feed and that the labour runs the cost up to from $100 to $105 per year. If the breeder adds to this interest on his investment in his bull and cost of housing he will likely find that it will not pay him to maintain a bull at $1 service fee. We figure that service fees should never be below $2 for a bull fit to use and that for better bulls the fee should range from $3 to $5 per cow. Of course, fees for outstanding high-priced bulls must be placed according to the value of the sire.

Regularity in feeding the bull is important as with other stock. Water should be available at all times and salt should be before him at all times. The bull is half the herd if he is a good one. If he is a cull he is all of it.

Selection and Care of the Breeding Females

Experience has proven that the beginner in beef cattle raising should, in proportion, put more money in the sire he is going to use than in the individual females of the herd, but it is, nevertheless, important that these females, whether for the production of pure-breds or grades, be carefully selected. No breeder of pure-breds can afford to neglect pedigree and family lineage in his selection, and no breeder of commercial cattle is justified in overlooking type and uniformity in his breeding herd. That same low-set, deep, blocky conformation already described as applying to the bull should prevail throughout the breeding herd of females. In starting a herd, if grades are to be used, it is wise to get cows that show at least three top crosses of good pure-bred sires, and five or six crosses are even more desirable. It is good practice to put into the herd cows that are uniform in type and not to mix breeds. Individuality in the cows is important, particularly in pure-bred herds.

In starting a herd, the beginner may find it to his advantage to buy fairly young cows with calves at foot and rebred. There seems to be no safer class of female to purchase. Such cows are proven breeders and the buyer generally gets three animals for his bid. Of course, thrifty heifers, safe in calf, are also a fairly safe investment.

SUMMER PASTURING

The care and management of the herd depends a good deal on the class of cattle being bred. As a general thing, however, the great bulk of the cattle composing the beef herds of the Province are summered on pasture, and the most satisfactory pasture seems to be a more or less permanent seeding of bluegrass. Mixtures of timothy, red top, meadow fescue and orchard grass, with alfalfa, red clover and alsike in varying proportions, are generally sown with a nurse crop of grain, but as years pass, in a permanent pasture, these satisfactory grasses and clovers are generally replaced by bluegrass. Where pastures of this kind are insufficient to meet the needs of the herd, certain annual crops may be used to supplement them. We have found that oats sown at the rate of three bushels per acre and seeded with either twenty pounds white sweet clover to the acre or a mixture of seven pounds red clover, four pounds alfalfa, two pounds alsike, and four pounds timothy to the acre makes a very satisfactory supplement to the older pastures. Sweet clover has also been used with fair success for beef cattle, and rape sown in the spring at the rate of two pounds

per acre in drills or from five to eight pounds broadcast makes a fair fall supplement. With all these supplementary crops better results usually follow their use in conjunction with the older bluegrass pastures. The same may be said of second-growth red clover or second or third crop alfalfa. Where the cattle have access to these softer feeds at the same time they have the run of the permanent pasture less scouring results, as compared with conditions necessitating that the entire feed be composed of these softer supplements.

In general practice the two most common mistakes in pasturing are turning the cattle to grass too early in the spring and allowing them to stay there too late in the fall. It is poor economy to force cattle that have been well wintered out on the grass while it is yet too young and watery. The stock scour badly, the grass is low in feeding value and the pastures get such a severe setback that they rarely recover during the entire season. Likewise, cattle that have been pastured on good grass and are in vigorous, thriving condition in the fall should be stabled at least at night before the weather turns too cold and rough and gives them a severe setback.

With the cows and heifers over one year of age most of which should run at pasture, as a general thing, it is not profitable to feed very much grain if the pasture is good. It is, however, under some conditions good business to provide silage to be used as needed to tide the cattle over the dry, hot period of midsummer short pasture. It may be necessary, too, with cows nursing calves to give from two to four pounds of grain per day if high condition on both cow and calf is desired.

Experience has shown that it not the best practice to turn the calves out to grass during their first summer whether they are pail fed or nurse the cows, although it is a good plan to arrange paddocks so that the calves may have outdoor exercise at night during the summer months.

Winter Care of Females

When the herd is brought in for the winter before the weather becomes too cold and stormy and the pastures have been picked too bare, they should carry on without any loss in condition. Under most conditions it is advisable to allow the breeding herd a few hours in an open yard on each fine day. In the best feeding practice, clover or alfalfa hay, corn silage and roots form the major portion of the roughage ration and for cows and heifers not required to be in high fit these may make up a very good ration with little or no grain. A good plan is to feed from three-quarters of a pound to one pound of clover or alfalfa hay per 100 pounds live weight of animal, from two to three pounds silage per hundredweight and about the same amount of roots. Where no roots are available the animal should get at least three pounds of silage per 100 pounds live weight, and where roots are fed and no silage they should be given at from four to six pounds per 100 pounds live weight. These amounts are for a daily ration.

If the feeder wishes to keep his cows that are nursing calves up in condition some grain is necessary, and oats should form the basis of the ration. With them may be mixed barley, corn, a little bran and possibly, for high-class cattle, a little oil meal. Grain rations for such cows will vary from two to three pounds per day up to six or eight pounds, according to conditions. Of course, these amounts would be too high in a commercial herd of grade cattle but are often used where show steers are produced by nursing the cows, and in pure-bred herds. The best practice, however, is to make the fullest possible use of clovers, alfalfa, roots and silage and feed the minimum amount of grain, as it is the latter that runs up the expense of carrying the herd.

The best possible system of maintaining the herd is through the selection of the highest quality heifers produced therein. They may be raised on skim milk, if it is a grade herd, or they may be allowed to nurse as is the case in most pure-bred herds. Daily exercise in an open yard through the winter and out only at nights in a paddock during the summer is the best known method of handling them. The plan should be to keep them growing and thriving well and it must be remembered that the first year of their lives is just about the most important in so far as future development is concerned. The gestation period is normally from 280 to 283 days and it is well to breed the heifers so that they will drop their first calves at about two and a half years old. Many believe that the best practice is to breed the beef cows and heifers to freshen in the fall. This practice distributes the labour a little better throughout the year and the cows generally milk fairly well on good feed during the winter and when they go out on grass the following spring the milk flow is again stimulated to the benefit of the calf. The attendant should be on hand at time of freshening and the cow should be fed a light ration only for a few days previous to and immediately after calving. If the calf is to suck the cow it should be left right with her in a loose box stall. If it is to be skim-milk fed less trouble may be experienced if it is immediately taken away from the cow and not allowed to nurse, but in all cases it should get the first milk or colostrum and should have whole milk for at least three weeks and then be gradually changed to skim milk.

FEEDING AT O.A.C.

Perhaps some figures on rations fed in the beef herd at the College would prove interesting and valuable, although these rations may be a little higher in grain than would be advisable on the average farm. A good average ration for mature cows nursing calves on winter feeding consists of forty-eight pounds of roughage per day including four pounds of straw, four pounds of hay, twenty pounds of turnips, and twenty pounds of corn silage. Along with this six and one-half pounds of grain composed of approximately five and one-half pounds of oats and barley mixed, equal parts, and just over one pound of bran was fed. At this rate, cows nursing calves cost 22.4 cents per day for feed. At the same time, dry cows of equal weight were fed a roughage ration consisting of forty-four pounds per day including four pounds of straw and twenty pounds each of roots and silage, and got two and one-half pounds of grain per day of the same mixture as before. In each case the straw was cut and fed along with the silage and pulped roots. Two-year-old heifers in the same herd consumed thirty-eight pounds of roughage per day including four pounds of straw and seventeen pounds of roots and silage, and received three and one-half pounds of grain per day from the same mixture as before. The cost of feeding for the dry cows was 14.8 cents per day and for the two-year-old heifers practically the same amount. Yearling heifers in the same herd received an average of thirty-four pounds of roughage per day including four pounds of straw, about fourteen and one-half pounds each of roots and silage, and a little over a pound of hay. These heifers also got three and one-quarter pounds of grain per day from the same mixture and cost 13.8 cents per day. It is obvious that these rations could have been cheapened somewhat by increasing the amount of clover hay and reducing the grain, but we often find it difficult to purchase good quality clover.

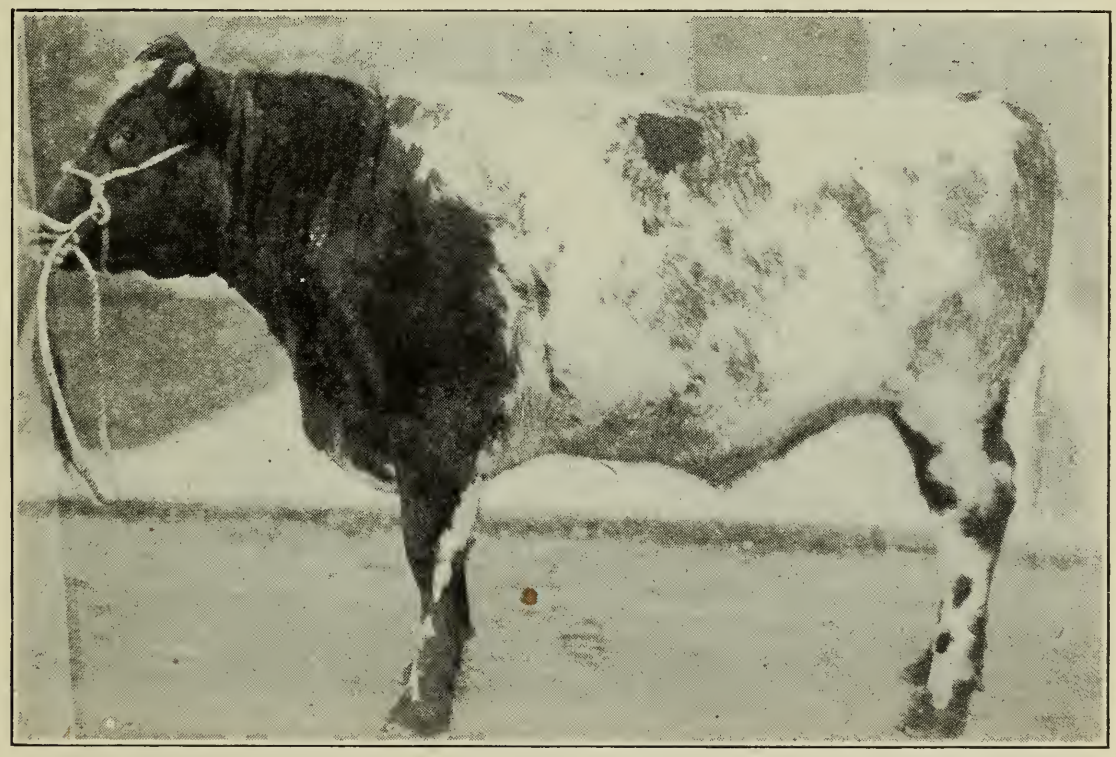
The prices of feed at which these figures were obtained were: Straw, $6 per ton; silage, $4 per ton; roots, 15 cents per bushel; mixed grain, $1.40 per hundredweight; bran, $1.35 per hundredweight; mixed hay, $10 per ton; salt,

$1 per hundredweight. We found that the cattle which had salt before them at all times consumed about 4/5 of an ounce per day, and they had an abundance of fresh water, which is essential to success.

HANDLING COMMERCIAL CATTLE

Selecting Stockers and Feeders

In selecting stocker and feeder cattle the buyer should keep in mind beef type, breeding, uniformity, quality and development for age. All cattle so selected should at least be sired by a pure-bred bull and should show as much breed character as possible. Blood tells, and, if it is practicable, it is well to select cattle which show similarity in breed character, because this makes for uniformity and uniformity always has a market value. For instance, a carload



Pure-bred Shorthorn steer. Bred and fed at the O.A.C. Weight at 2 years 1,600 lbs. A good type of heavy export steer.

of cattle of the same breed and colour, of equal weight and finish will generally meet a more ready sale than a mixed lot. Quality is important and size for age is a factor because stunted cattle rarely come back and make the gains that thrifty cattle do. It is well to select cattle that are low to the ground, showing short, broad heads with strong muzzles and with plenty of heart girth and middle giving every indication of being able to handle large quantities of feed to advantage. The long-legged, shallow-bodied, wasp-waisted, weak-muzzled, cat-hammed steer is almost invariably a poor doer and a money loser. As mentioned elsewhere, the original weight of feeding cattle is important, because whatever spread in price the feeder obtains shows, of course, a profit on this original weight, and for short-keep steers the heavier feeder often gives a greater chance for profit whereas for the long-keep cattle lighter steers are often selected.

Stall Feeding Market Cattle

Most of the stall feeding of steers for commercial purposes in the Province of Ontario is done during the winter months. The class of steer which is fed has changed somewhat during recent years owing to the demands of the consuming public. In these days of small families and high living costs, the consumer demands small cuts of high quality meat which can only be obtained from handyweight carcasses. The feeder also realizes that the young and growing animal makes the cheapest and most economical gains, therefore the man who breeds, raises and finishes his own steers is well advised to get them on the market before they are thirty months of age, and most of them go forward at between eighteen and thirty months old. This is quite different from the days of the three and four-year-old steer of a few decades ago.

Two methods are followed in stall feeding. One, the use of box stalls or sheds in which the cattle run loose, and the other where the cattle are tied in

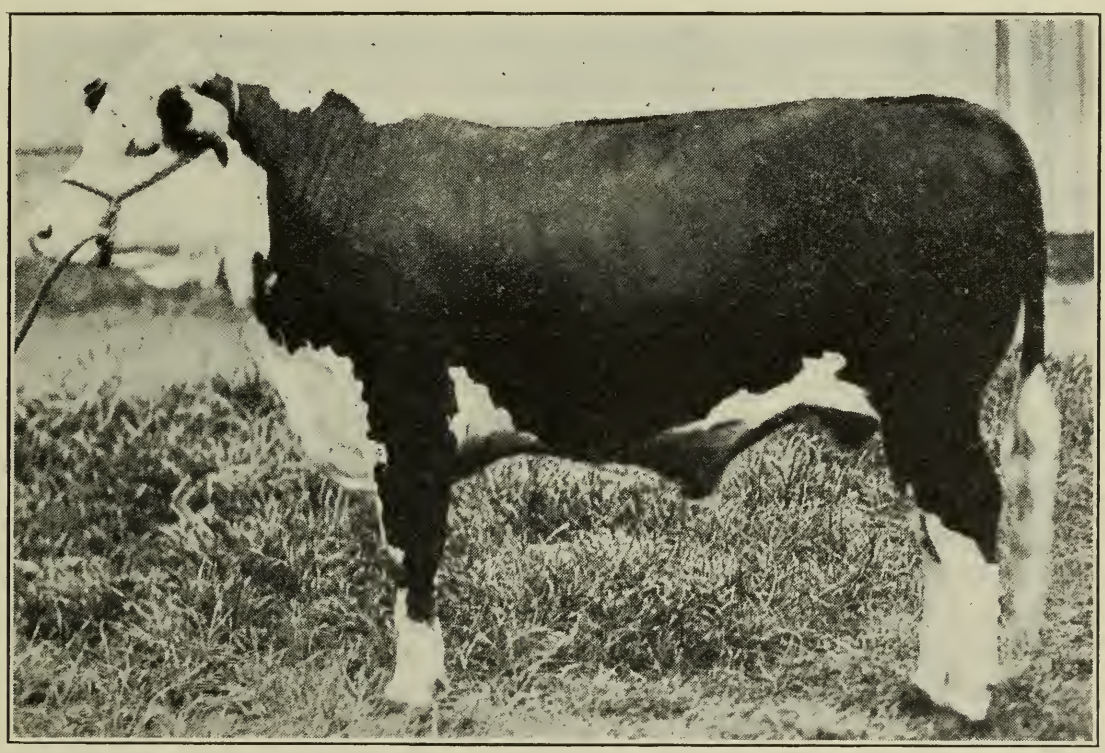
Pure-bred Aberdeen Angus steer. Bred and fed at the O.A.C. Weight at 18 months, 1,000 lbs. An excellent baby beef or handy weight butcher steer.

stalls. Experiments have proven that expensive structures are not necessary in which to fatten steers and that a good open shed may be just as satisfactory as an expensive, underground stable. Experimental work has also proven that steers will generally do a little better fed loose than when tied and will make higher returns for feed consumed. Moreover, the steers fed in the loose boxes are less liable to go off feed, are not so likely to suffer from sore feet, and do not show the same tendency to scour on heavy feeding, and seem to stand up better in shipment. Of course, all steers so fed should be dehorned and where the feeder may be finishing range cattle in the stall it is almost imperative that they be fed in loose boxes rather than tied.

Short Keep or Long Keep Steers

In stall feeding where the cattle are purchased for finishing purposes two methods are followed, namely, the buying of what are often termed short-keep steers as against the purchase of thinner, lighter cattle commonly called long-keep

steers. Short-keep steers are generally heavy, fleshy cattle carrying a good deal of condition and may be finished in from two to three months, while the longer keep cattle are the thinner kind which may be fed from five to eight months. In purchasing cattle to finish the original weight is a big factor in the results obtained. Any spread in price between the buying and selling figures makes for greater profit when figured on a fairly heavy original weight. Thus, if a feeder buys cattle at five cents per pound and sells them for seven cents when finished, a steer that weighed 1,000 pounds at the beginning of the feeding period would yield an increase of $20 over and above that made from the gains put on; whereas one that weighed 700 pounds at the beginning of the feeding period would yield a similar increase of only $14. It will be seen, therefore, that when one is buying steers to finish the original weight is important, but it must also be remembered that short-keep steers for feeding purposes usually



Pure-bred Hereford steer. Weight, 1,100 lbs. at 17 months. A good type of baby beef bred and fed at O.A.C.

cost more per pound than long-keep steers and may be handled at a smaller spread in price between the buying and selling figures than may the long-keep steers. With favourable conditions, to make a reasonable profit, where around three-quarters to one cent per pound spread in price may be necessary with short-keep steers, from one and one-half to two cents per pound spread will likely be necessary with the long-keep steers. Experiments at the Ontario Agricultural College, when costs of production were lower than they are to-day, showed that when short-keep steers were bought at five cents per pound and sold at five and one-half cents they yielded returns for feed consumed almost identical with those of long-keep steers, bought at four and one-quarter cents per pound and sold at five and one-half cents. We are safe in saying that, all things being equal, the spread in price on long-keep steers should be at least double that on short-keep steers to make them equally profitable. Of course, there is a difference in the feeding practice followed with these two different types of steers. Short-keep steers are put on the maximum grain ration as quickly as possible, whereas

the long-fed steers are started on a light grain ration and more gradually increased. It is a good practice to start the short-keep steers on from four to five pounds of meal per day, provided they weigh 1,000 to 1,200 pounds, and gradually increase until they are getting eight to ten pounds of meal per day; whereas with the long-keep steers it is well to start with two or three pounds per day and make the increase much more gradually up to the maximum of eight or ten pounds per day at the close of the feeding period. More use of roughage and cheaper feeds may be made in the case of the long-keep steers.

Grass Cattle

In some sections of Ontario large numbers of cattle are fattened off grass with fairly good results. Of course, rough land may always be used for grazing purposes but there are sections of excellent tillable land, particularly in parts of Middlesex, Lambton and Huron counties, which are almost entirely devoted to grazing of beef cattle. Of course, there are smaller areas in many other counties similarly handled. With good grass in the form of permanent pastures largely composed of bluegrass, grazers figure on about twenty-five heavy steers per 100 acres. By heavy steers is meant cattle from 1,100 pounds up, and investigation has shown that to make a success of the grazing business it is nece sary to have more than 200 pounds of beef to the acre. It has also been shown that for highest results, even in the good grazing areas, that from 30 to 40 pe cent. of the returns from the farm should come from cash crops or sources other than the beef cattle specialty.

It should also be noted that the cattle which make the highest gains on grass are generally well-bred cattle in good thriving condition but not carrying very much fat when they first go to grass. Cattle that have been heavily grain fed during the winter, and particularly fat young cattle, are liable to go back unless the pasture is particularly luxuriant. In five groups of cattle fed at the Ontario Agricultural College and averaging just over 700 pounds each when turned to grass after a winter of generous grain feeding the average loss per steer during the first week on grass ran from 81.7 pounds in the thinner steers to 98.3 pounds in the fattest group, and these steers continued to lose weight during the second week on grass. In three weeks after going out all groups were gaining, but they did not get back to their stable weight until nine weeks after they were first turned out and consequently made rather poor gains for the summer even though they were on good grass. It would seem, then, that it would be more profitable to market fairly well finished young cattle rather than turn them to grass, whereas older, heavier and thinner cattle will make rapid gains on good grass.

For pasture for beef cattle no other feed seems to equal bluegrass for the production of rapid gains and firm fleshing. Mixtures of timothy and the clovers are fairly satisfactory, but the clovers, including alfalfa and sweet clover, while they may produce a luxuriant growth, are not as satisfactory in beef production as they are for dairy cattle so far as pasturing is concerned. However, fair results have been obtained from mixtures and from alfalfa and from sweet clover, but it is well where one is using these as part of his pasture system that he have a permanent bluegrass pasture as a part of the ration for his cattle. The same may be said where rape is being used as a fall pasture. Rape makes a fairly satisfactory pasture for beef cattle, but, unless it is used in conjunction with an old pasture, cattle are liable to scour badly, and, as with sweet clover or alfalfa, it is generally profitable to use the rape in conjunction with an old bluegrass pasture.

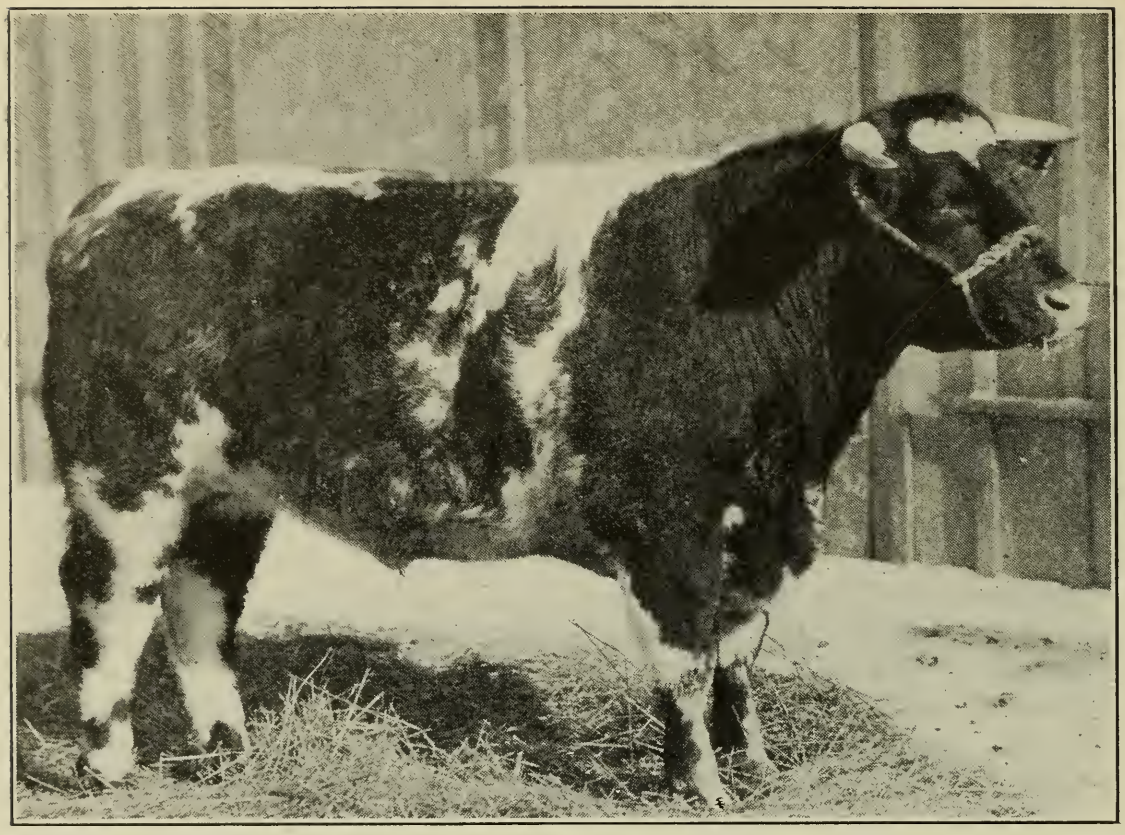
BABY BEEF

In these days, with the market demand for light or handyweight cattle from which the high-class small cuts are obtained, the production of baby beef is important and real high quality baby beeves usually sell at or near the top of the market. A few years back an effort was made to put this class of cattle on the market at around fourteen or fifteen months of age, some going forward even younger than that. Butchers and abattoir men now claim that the beef does not attain its best flavour until the animal is seventeen or eighteen months of age. It is a well-known fact that there is a stage in the animal's life between the veal weight and the beef weight during which it does not make very satisfactory meat, being rather tough and stringy and lacking flavour, so that it is important that cattle finished for baby beef carry not only the best possible beef type and finish but that they have reached the right age to insure good flavour.

Of course, the best quality of baby beef is made from well-bred cattle that have been allowed to nurse their dams. Most feeders believe that whole milk is necessary in the production of baby beef, and, undoubtedly, the highest quality product is obtained from cattle which nurse until at least nine or ten months old. Experiments at the O.A.C. have proven that under average conditions with good grade cows reasonable profits may be made from the raising of baby beef where the calves suck the cows. In addition to the whole milk, as soon as the calves will eat it, good alfalfa hay, pulped roots, silage and, while the calf is young, whole or rolled oats to which a little oilcake has been added, and later during the finishing period a mixture of barley and oats or corn and oats are amongst the best feeds to be used. In all steer feeding it is well to remember that around a pound of good alfalfa hay per 100 pounds live weight and an average of one-half pound of grain per 100 pounds live weight during the feeding period generally brings good results. Usually the feeder starts with a smaller proportion of grain than that mentioned, gradually increases until the middle of the period when the animal gets the rate mentioned, while at the end of the period he may be getting nearly a pound of grain per 100 pounds live weight per day. In the handling of baby beeves, it is well not to let them out on grass unless it be in paddocks and only at night. All young cattle, particularly calves that are being pushed for rapid gains, do better kept in partially darkened box stalls during the day throughout the summer. It is wise, however, to let such cattle have some outdoor exercise both winter and summer. An hour in the open yard on fine days in winter and spending the nights in the paddocks during summer makes for greater vigour and bigger returns.

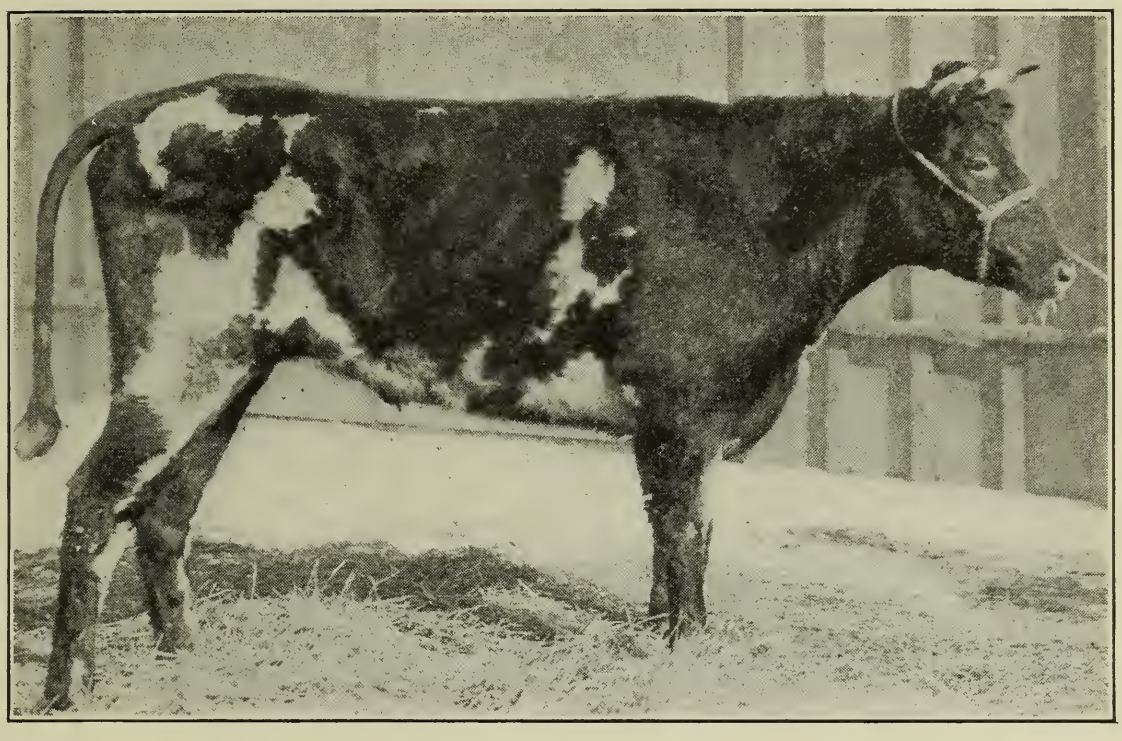
Making Baby Beef on Skim Milk

In order to test the possibilities of making baby beef on skim milk, four good grade Shorthorn calves were changed from whole to skim milk at about three weeks of age and were run through to marketing without any whole milk from that time forward. These were calves of good type and quality, and from the beginning made very satisfactory gains, and when marketed, while not *prime*, were considered to be *choice* baby beeves. A record of their feeding and gains is interesting and shows that there are possibilities in the direction of skim-milk baby beeves although one cannot hope to get the same finish and prime condition as where whole milk is used. The calves in this experiment were put in, as the table shows, in late January and February, 1924, and they were marketed at

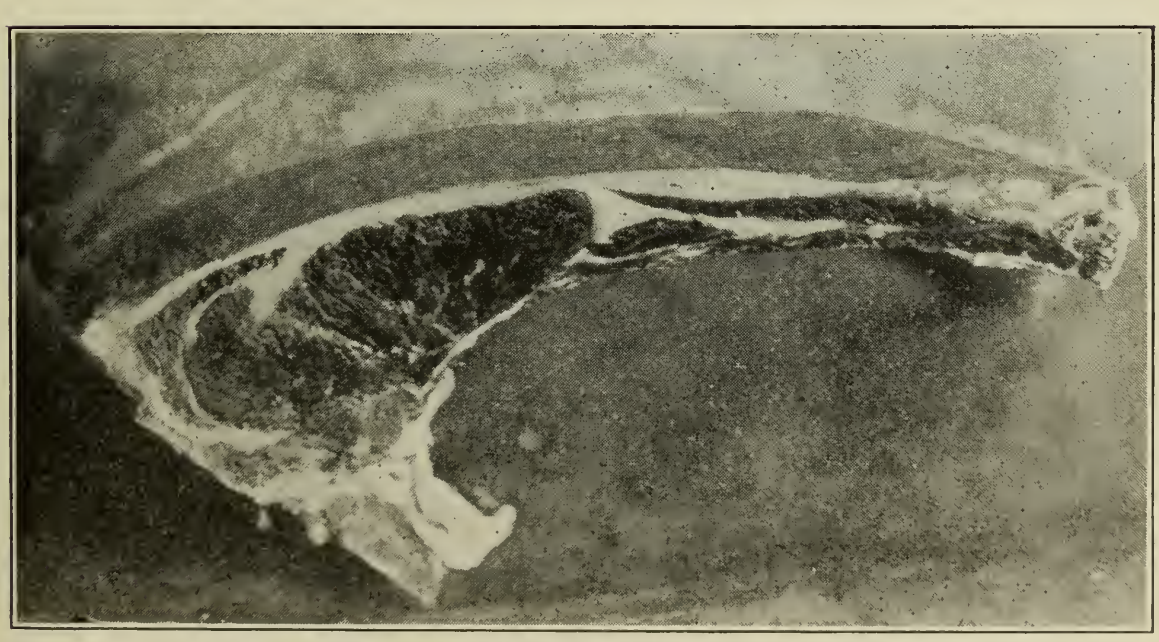


A 1,400-lb. 2-year-old steer, by a pure-bred sire and out of a pure-bred cow. This steer was bred and fed at the O.A.C. and dressed 65.7%.

Prime ribs out of the prime steer shown above.



A 1,000-lb. 3-year-old scrub steer killed at the O.A.C. He dressed 56.5%.



Prime ribs out of the scrub steer shown above.

the end of January, 1925, averaging right around a year old and averaging in weight just about 800 pounds each. They were considered by the butcher who bought them to be choice, handyweight cattle, reasonably well finished and just about what the average market requires. These calves were not turned out to pasture during the summer months but were kept in a large, roomy box stall in the day time and allowed out in the paddocks at night. The flaxseed jelly mentioned in the table was made by boiling ground flaxseed at the rate of a pound to a gallon of water until it jellied. This was fed until the 18th of October along with the skim milk, at which time the calves were weaned. It is worthy of note that during the last month the calves were getting skim milk and flaxseed jelly, the four made a gain of 280 pounds, whereas during the first month after weaning they made a gain of only 130 pounds, but during the second month after weaning this was increased to 225 pounds and in the third month to 245 pounds. It will also be noticed from the tables that the change from whole milk to skim milk was gradually made. This makes the amount of skim milk per day in the second month in the calf period appear small. The accompanying table shows the rations fed during the first three months of the calf period, throughout the growing period, and the finishing period, and following this table is a statement showing the financial returns from this experiment with feed prices charged at the barn. These prices were market prices for the feed during the period of the experiment. With well-bred grade calves by a good pure-bred bull it would appear that there are possibilities for making baby beef even from skim milk where a fat substitute is used.

First Month in Calf Period

Days	Feeds	Total feed	Daily rations	Remarks
January 25th to February 24th, 31 days.	Alfalfa.....	68 lbs.	1.096 lbs.	Only two calves feeding in first month.
	Oats.....	39 lbs.	.627 lbs.	
	Sweet milk...	930 lbs.	15. lbs.	Daily gain 1.77 pounds.
	Linseed jelly..	10 lbs.	.161 lbs.	

Second Month in Calf Period

February 25th to March 24th.	Alfalfa.....	190 lbs.	1.638 lbs.	
	Grain.....	121 lbs.	1.043 lbs.	Mixture {Oats.....8, Bran.....2, Oilcake.....1}
29 days.....	Sweet milk...	870 lbs.	15. lbs.	Two older calves.
	Flaxseed jelly.	10 lbs.	.172 lbs.	To two older calves.
29 days.....	Whole milk...	265 lbs.	9.13 lbs.	
	Skim milk....	25 lbs.	.862 lbs.	Calf No. 3.
22 days.....	Whole milk...	195 lbs.	8.86 lbs.	Calf No. 3—started in exp., March 3.
	Skim milk....	25 lbs.	1.136 lbs.	Daily gain 1.67 pounds.

Three to Four Months in Calf Period

March 25th to June 24th (inclusive).	Hay	1,085 lbs	2.95 lbs	Alfalfa.
	Skim milk	6,252 lbs.	16.99 lbs.	
	Flaxseed jelly	50.75 lbs.	.1379 lbs.	
92 days	Grain	701 lbs.	1.904 lbs.	Mixture {Oats 8, Bran 2, Oilcake 1}
				Daily gain 1.8 pounds.

Growing Period

June 25th to October 24th (inclusive).	Hay	2,465 lbs.	5.051 lbs.	Mixed hay.
	Silage	6,780 lbs.	13.89 lbs.	
	Grain	1,413 lbs.	2.89 lbs.	Mixture {Mixed grain 8, Bran 2, Cake 1}
122 days	Skim milk	8,280 lbs.	17.84 lbs.	Fed to October 18th, 116 days.
	Flaxseed jelly	72 lbs.	.155 lbs.	Daily gain 2.407 pounds.

Finishing Period

Days	Feeds	Total feed	Total Daily rations	Remarks
October 25th to January 24th, 92 days.	Hay	1,805 lbs.	4.9 lbs.	Mixed hay.
	Silage	9,100 lbs.	24.72 lbs.	
	Turnips	600 lbs.	24.59 lbs.	Last 61 days only.
	Grain	1,781 lbs.	4.84 lbs.	Mixture {Mixed grain 8, Bran 2, Cake 1}
				Daily gain 1.63 pounds.

Statement

Total weight at close of period		3,210 lbs.
" weight when entered		460 "
Total gain		2,750 lbs.
Daily gain per steer		1.961 lbs.
Cost of feed	$197 15	
Cost of feed to produce a pound of gain		7.169 cts.
Cost per pound (including original weight)		6.141 cts.
Selling price	Per lb.	8 cts.
Selling price, 3,150 pounds (shrunk weight) at 8 cents per pound	$252 00	
Total cost of all feeds fed	197 15	
Profit over cost of feed	$54 85	
Original cost of calves, 4 calves at $5.00 each	20 00	
Total profit	$34 85	

Feed Prices Used

Alfalfa hay	$15.00 per ton	Flaxseed	$3.50 per cwt.
Mixed hay	$12.00 per ton	Bran	$29.00 per ton
Corn silage	$4.00 per ton	Mixed grain	$1.50 per cwt.
Turnips	10 cts. per bushel	Skim milk	25 cts. per cwt.
Oats	48 cts. per bushel	Whole milk	$1.50 per cwt.
Oilcake	$50.00 per ton		

The Veal Calf

While a large percentage of the veal produced in the Province of Ontario comes from calves of dairy breeding, that of the best quality will continue to be produced from beef type cattle and particularly those sired by pure-bred beef bulls. No other system makes as satisfactory veal as allowing the calves to nurse the cows. Whole milk is the best veal producer known and the calves should be marketed at from 120 to 220 pounds, around 180 pounds being a favourite weight. Along with the whole milk a little alfalfa hay as soon as they will pick it, pulped turnips or mangels, and crushed oats with a little oilcake added, comprise an excellent ration.

If it is necessary to veal the calves on skim milk, it is well to add to the milk a little flaxseed jelly. This is made by boiling at the rate of a pound of ground flaxseed to a gallon of water until it jellies, starting with about one tablespoonful of this jelly for a very young calf and gradually increasing until he is getting from one-half to three-quarters teacupful in his milk ration. This will, to some extent, take the place of the butter fat which has been removed from the milk by the skimming process. Such a calf should get also good alfalfa or red clover hay, a mixture of oats and oilcake as soon as he will eat, and finely pulped roots or silage, preferably the former. Veal calves should be kept inside during the summer as they do better than if they are turned out in the hot sun and so exposed to the flies.

A Good Basis for Computing Rations

Assuming that the feeder has at his disposal good clover or alfalfa hay, corn silage, roots, and mixed grains, including oats, the following is a good basis for computing rations: Give the animal a pound of hay per 100 pounds live weight and from three to five pounds of a mixture of silage and roots, using the larger amount if roots predominate in the feed, and the smaller amount if the succulence is mostly supplied from silage. If no grain is to be fed, the amount of hay should be increased by about one-half, but if grain is fed use for nurse cows about one-half pound per 100 pounds live weight, for dry cows about two pounds per cow and for developing heifers from two to three and one-half pounds per heifer. For fattening steers, it is well to start with a small amount of grain, and for the feeding period about one-half pound on the average, per 100 pounds live weight, is near the mark, starting from very little and reaching this rate at about the middle of the feeding period and finishing at something near one pound of grain per day per 100 pounds live weight. It is well to use oats and perhaps a little oilcake for the growing calves. A mixture of half oats and half barley with a little bran, four or five of the former to one of the latter, is satisfactory for the cows and developing heifers, and a mixture of oats and barley or oats and corn for finishing steers. To obtain the highest possible degree of finish, from a pound to a pound and a half of oilcake per steer per day in the grain mixture will prove beneficial. This, with salt and water always before the cattle, will ensure fairly good feeding, but the attendant must always take into consideration the individuality of his animals and be guided by their likes, dislikes and capacities. As a general thing calves prefer mangels to turnips, but for bulls, feeding steers and the older cows and heifers turnips may prove just a trifle better than mangels, although both are good, and the only danger from mangels is from the formation of calculi in the urethra in males.

Castration

It is important that all male calves not intended for breeding purposes be castrated at an early age. In fact, beef cattle breeding would take a rapid step

forward if a number of the more inferior of the pure-bred male animals were also castrated. Castration always increases the meat value of the animal and should be done before there is any danger of the calf showing a staggy appearance. All things considered, the best time to castrate the calf is from three weeks to two months of age, according to the growth and vigour of the calf. Of course, it is not necessary, nor is it advisable, to castrate calves that are being marketed for veal, but all male calves that are to be sold as beef at six months or more of age should be castrated. Four months of age is the oldest date at which one may be reasonably sure that stagginess has not developed, but the animals may be castrated even up to six or eight months of age and some of them not show any great amount of coarseness thereafter. To be safe, however, it is much better to perform the operation at from three weeks to two months of age.

All that is necessary to successfully perform the operation is a sharp knife and some disinfectant. A 3 per cent. solution of any of the standard disinfectants will answer. If the calf is castrated when he is young, as hould be the case, no trouble is generally met in securing the animal. A good practice is to turn the calf over on his back and by the use of a hame strap fasten the fore and hind legs on either side together. The scrotum should be washed with a disinfectant and either one of two methods should be followed. If the animal is to be retained for show-ring purposes it is advisable to make two incisions running up and down the scrotum, being careful to cut right through to the end to permit of drainage in healing. One should not be afraid to make a good, large incision. Each testicle is removed through a separate incision in this method and should be drawn so that at least one inch or more of the cord is removed with it. In older animals, the cord should be severed by a scraping process, but in young calves may be simply cut off or pulled away. The other method is to simply cut off the end of the scrotum removing about one-half inch, after which the testicles may be drawn, both coming away through the one incision. A liberal use of the disinfectant after the testicles are drawn should be made and, usually, while some swelling will develop, no further trouble results. The first mentioned method is the best if one desires his steers to show the fullest possible scrotum when fat.

If old bulls are to be castrated greater precautions are necessary and an emasculator may be used for pinching off the cords or they may be seared off with a red-hot iron. If the operation is performed during fly time, pine tar should be applied to the wound to keep flies away and if, from neglect, the wound becomes maggoty, applications of a little turpentine or chloroform or gasoline will usually clean out the worms and allow healing to commence. It is advisable to keep newly castrated calves in box stalls rather than tied up in order that they get exercise. In summer, it is well to keep them inside during the day and allow them out at night to prevent fly trouble.

DEHORNING

Because of the injury to cattle in transit a large percentage of which is caused by horns, and because of the greater ease with which large numbers of feeder cattle may be cared for in feed lots, dehorning is gradually meeting with greater favour. In fact, markets pay a premium for dehorned cattle and there is no reason why cattle intended for the production of beef, both heifers and steers, should not have their horns removed. In herds of pure-bred breeding cattle there is argument against dehorning because unless the animal is vicious the horns may be attractive and in some breeds their shape and quality form a

distinct breed characteristic. The writer is not in favour of dehorning high-class pure-bred stock, but for all commercial cattle intended for beef purposes dehorning is to the advantage of the breeder and feeder, the shipper and buyer, and the killer and packer. The advantages of dehorning are:

1. The animal is more tractable, more easily handled.
2. Dehorning prevents injury in the feed lot, or on the way to market.

NOTE.—There is usually less shrink amongst dehorned than horned cattle on the way to market.

3. Dehorned cattle have an equal chance in feed lot or loose box feeding.
4. Dehorning makes for more uniformity in appearance, which has a market value.

The best time to dehorn and the simplest and easiest method for the Ontario farmer is to use caustic potash on the calves, preferably before they are three weeks of age and better success generally follows at from one week to ten days old. There is nothing difficult about the caustic potash treatment. The breeder should get the caustic pencils from the drug store, and, after clipping the hair from around the knobs or scurs where the horns are starting, a little vaseline should be applied around the edge of the hair. This will prevent the caustic from spreading to cause a sore on the skin around the horns. The attendant must be careful not to get the caustic on his fingers. He should wear an old pair of gloves or should have one end of the caustic pencil wrapped to prevent this. Then, the other end of the caustic stick should be dampened and the knob or scur thoroughly rubbed with it. Care must be taken that the caustic pencil is not so wet that the part of the pencil dissolved will run down the side of the head of the calf. Calves treated should be kept inside in a box stall for a few days. If caustic is rubbed on the scurs and they are turned out in the rain it is liable to run and burn. In the application of the treatment, care should be taken to give the scurs a thorough rubbing so that they are killed. If this is done, in a few days scabs appear which soon fall off and the calf never produces horns. By giving two such treatments we have successfully killed the horns on calves more than a month old but often, with these older calves, scurs or nubbins develop. It is advisable to apply the caustic before the animals are two weeks old and, as previously stated, when they are around seven days to ten days old is the best age and when applied properly at this age the calf seems to go ahead without apparent loss from the operation.

Where calves have been neglected and their horns have grown and where these cattle are to be placed into feed lots it is often advisable to dehorn by use of either dehorning saws or dehorning clippers. For younger cattle the clippers are preferable, but for some old cattle, with very heavy horns, the saw should be used. Clippers are quicker and less painful to the animal; the saw does not crack the horn to the same extent nor do cattle bleed so profusely when the horns are sawn off as when they are clipped. From experience with both methods we prefer the clippers for all but old, heavy-horned cattle.

In dehorning, the one thing that the attendant should be most particular about is that the animals are properly secured before cutting is commenced. If an animal breaks away with one horn off and the other still to be removed severe loss in weight is almost sure to take place. Of course, losses occur in dehorning but very few cattle actually succumb to the operation. In an experiment at the College fourteen steers were dehorned. In this experiment it was found that steers with small, fine horns lost very little in weight while those with larger heavier horns got a severe setback. In the first week after dehorning

the fourteen steers showed an average loss of twenty-three pounds per steer and in the second week the steers showed an average loss of nine pounds per steer, making an average loss of about thirty-two pounds per steer in the first two weeks, followed by an average gain of 16.6 pounds per steer in the third week. There was one steer in the lot that broke away and naturally went half mad. This steer lost eighty pounds the first week and it was nearly a month before he was back to normal. On actual feed and records after dehorning it paid to dehorn these cattle, but it was noticed that the steers in highest condition received the greatest setback from the practice. The time to dehorn, if the horns have been allowed to remain on the calves, is before the cattle go into the feed lots and while they are in low condition.

Dehorning should not be done in warm weather. Of course, horns may be stopped with caustic potash at any season. If there is any danger whatever of flies some fly repellent should be used. It is good business, after the horn has been cut off, to apply pine tar with an old paint brush or swab. It is not necessary to wrap the wound, and in cutting the horn it is well to cut as close to the poll as possible, slanting the incision from the top of the horn to the bottom. Bleeding is rarely dangerous but some fine flour may be used to aid clotting if the flow of blood appears too heavy. Generally speaking nothing is necessary. Late fall and early spring are the best seasons for removing horns, and, where the feeder has a large number to dehorn, a permanent dehorning stanchion set at the end of a chute with strong side rails, preferably of metal, may be found advisable. The job may be done, however, by securing the animal to a strong snubbing post. It is better not to do the dehorning in the stalls on account of the blood.

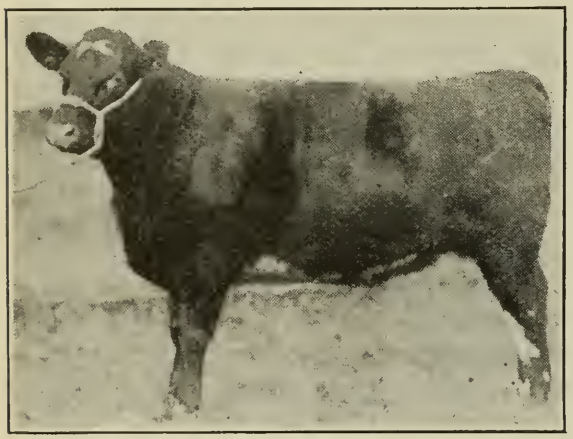
The Importance of the Sire in Beef Production

While the great majority of the cattle marketed for beef are, and must continue to be, grades, the beef producer cannot afford to overlook the importance of using a pure-bred sire of high quality in the production of commercial cattle. From a survey of the beef cattle district in Middlesex County, it was noted that the percentage of farms carrying profitable cattle was almost twice as great where pure-bred bulls had been used for over ten years as compared with farms where grade bulls had been in use for a similar length of time.

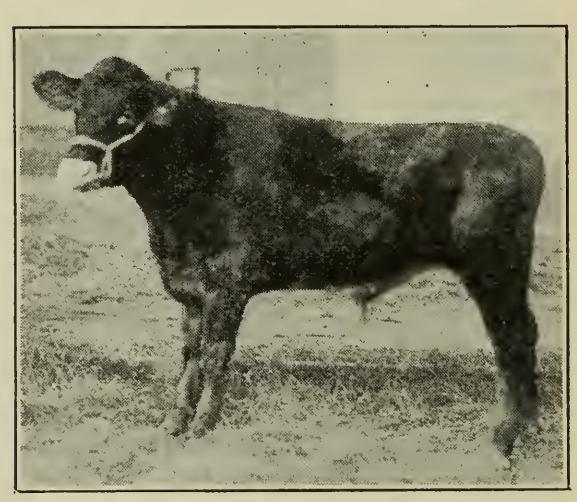
Two separate and conclusive experiments have been carried on at the Ontario Agricultural College and in each case cattle sired by a pure-bred bull have returned greater profit than those sired by grade or scrub bulls. In the first experiment, three pure-bred steers, one representing each of the three breeds, Shorthorn, Hereford, and Angus, were used as one group. A second group comprised three steers of a Hereford-Shorthorn cross. The third group was made up of three grade steers sired by a pure-bred Shorthorn bull. The fourth group was made up of three steers sired by a grade or scrub bull, and a fifth group was composed of three Holstein steers. These cattle were put in as calves at from four to six months old and practically equal in weight, and were all put on the same rations, and were carried through two winters and one summer, the feeding period starting in October. The three first mentioned groups made a profit over and above all costs of feed, labour, housing and marketing of $36.18. These included all the beef-bred steers sired by a pure-bred bull, while the two latter groups, including the scrub steers and Holstein steers, showed a loss of $91.84. Perhaps, for the average feeder, it would be best to compare the three grade steers sired by the pure-bred Shorthorn bull with the three scrub steers of beef breeding. The three grade Shorthorns showed a

profit over all expenses of $14.70, whereas the three scrub steers showed a loss of $22.73. It might also be mentioned that the dairy-bred steers were most unprofitable, showing a loss of $69.11. When put on the Toronto market, all of the beef-bred steers sired by a pure-bred bull brought fourteen cents per pound as compared with eleven cents per pound for the scrubs of beef breeding and nine cents per pound for the dairy-bred steers and there was a similar difference in the price of the carcasses. All through the transaction, the advantage showed distinctly in favour of the steers sired by a pure-bred beef bull. The experiment proved that there was no advantage in holding dairy calves to be marketed as two-year-old steers and that, for practical purposes, further investigations in regard to commercial cattle could be limited to good grade steers sired by a pure-bred beef bull against beef-bred steers sired by a grade or scrub bull.

A second experiment was carried out with calves started soon after they were dropped. These calves were carried through and marketed when they reached two years old and, owing to the fact that prices took a decided drop in the interval, all showed a loss, but the four sired by the pure-bred bull brought



Type of good grade by a pure-bred bull used in experiment at O.A.C.

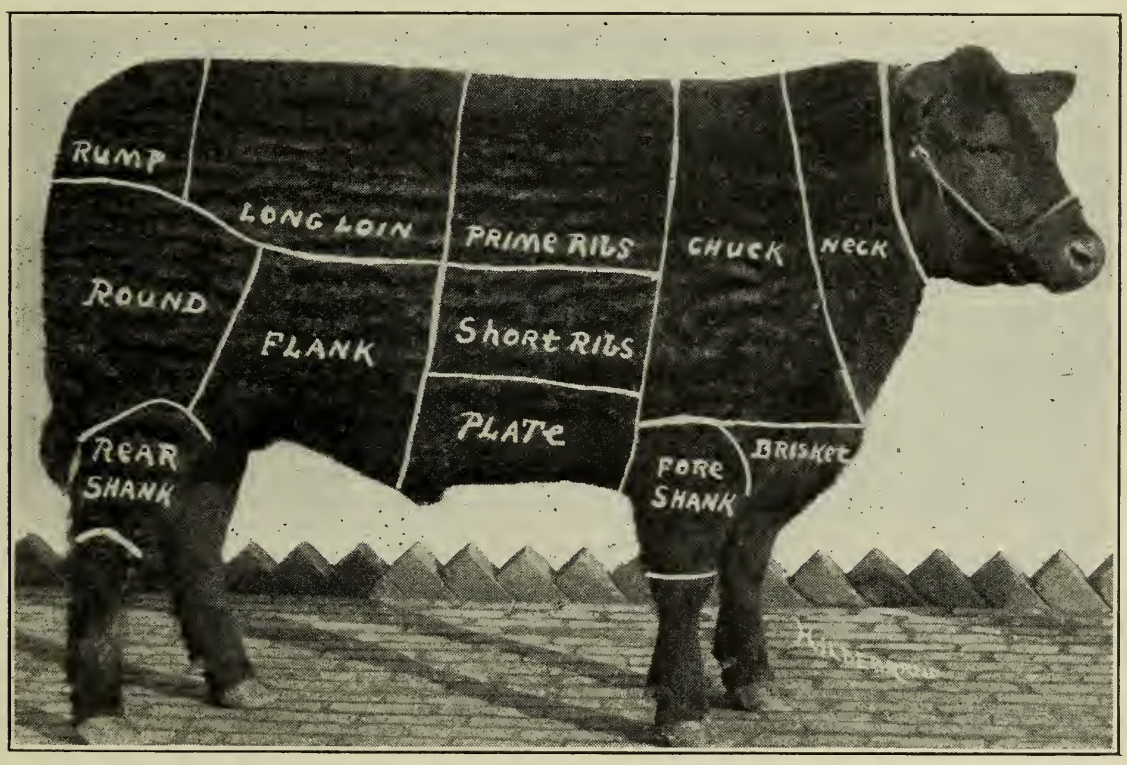


Type of steer by scrub bull used in experiment at O.A.C.

seven cents per pound, while those sired by the scrub bull brought only four and three-quarters cents per pound. All the cattle had received exactly the same treatment throughout their life and the carcasses from the four sired by the pure-bred bull all graded prime and were valued at thirteen cents per pound, whereas the carcasses from those sired by the scrub bull showed some variation, two grading common at nine cents per pound, one medium at ten cents, and one choice at twelve cents. The average dressing percentage of those sired by the pure-bred bull was 61.8 per cent., whereas the average of those sired by the scrub bull was 58.9 per cent. Marketed at the best possible weight, the grade steers sired by the pure-bred bull showed an advantage of $8.33 per steer over the scrubs.

It is interesting to note from these two experiments that in the former the difference in price per pound when cattle prices were high showed an advantage of three cents per pound live weight in favour of the cattle sired by the pure-bred beef bull as compared with those sired by a grade or scrub bull, and when prices were low, as was the case in the second experiment, the difference was two and one-quarter cents per pound in favour of cattle sired by a pure-bred bull. This means an average of about 2.6 cents per pound in favour of steers

sired by a pure-bred bull and they also make more rapid gains. These figures correspond with some work done by an Ontario farmer over a period of several years in which his results show an average of $26.00 per steer more for those sired by a pure-bred bull as compared with steers bred in his own herd and sired by a grade bull. It would appear, then, that for 1,000-pound steers one could reasonably expect from two and one-quarter to three cents per pound higher rate for those sired by a good pure-bred bull as compared with those sired by a scrub or low grade bull, all conditions of feeding and care being equal, and this is sufficient to make the difference between profit and loss in beef cattle feeding, being as it is, a difference of $22.50 to $30.00 per steer. It should be noted that, in the experiments carried on at the College, we had to pay higher than beef value for the calves sired by the pure-bred bull in order to get them, and this, of course, cut down the actual profits somewhat, but there is no doubt but that the pure-bred sire of the right type is one of the most important factors in beef production.



Showing the wholesale cuts on Glencarnock Victor 2nd. A Chicago champion and an excellent type of show steer.

SHRINK IN SHIPPING

Another interesting point might be mentioned here. The fifteen steers in the first experiment weighed 15,045 pounds at the barn on the morning of shipping. They weighed 14,685 pounds at the depot after having been driven two miles, making a shrinkage of 360 pounds or twenty-four pounds each. They weighed 13,857 pounds on Toronto market, approximately fifty miles from point of shipping, making a total shrinkage from stable to market of 1,188 pounds, or an average of 79.2 pounds per steer, or an average percentage shrink of 7.8 per cent. from barn to market.

CUTS OF BEEF

The accompanying marked photograph shows where the various wholesale cuts of meat come from. It is interesting to note that the loin and rib, which

are the most valuable cuts, average about twenty-six per cent. of the carcass; that the rounds, which are the next most valuable cut, average about twenty-three per cent. of the carcass, and that the chuck, a cheap cut, averages about twenty-six per cent. of the carcass, the remaining twenty-five per cent. being made up of plates, flanks, shanks and suet. The loin and ribs are approximately one-quarter of the carcass but furnish just about half its value, whereas that half of the carcass including the loin and ribs and the round furnishes about three-quarters of the value of the entire carcass. Thus, we see the importance of having our animals well ribbed up and showing strong loins and full rounds, all extremely well covered with flesh.

The commoner grades of cattle dress from fifty to fifty-eight per cent., whereas the best cattle dress around sixty per cent. and real top show steers may run from sixty-four to sixty-six per cent.

A MARKET CLASSIFICATION FOR BEEF CATTLE

Key: Roman numerals equal market class.
Letters in brackets equal market sub-class.
Numerals equal grade.

Killing Grades

I. Export Steers, 1,200 pounds and up.
1, prime; 2, choice; 3, good; 4, medium; 5, common.

II. Butcher Cattle.
(*a*) Steers, heavy weight, 1,000 to 1,200 pounds.
1, prime; 2, choice; 3, good; 4, medium; 5, common.
(*b*) Steers, light or handy weight, 700-1,000 pounds.
1, prime; 2, choice; 3, good; 4, medium; 5, common.
(*c*) Heifers.
1, prime; 2, choice; 3, good; 4, medium; 5, common.
(*d*) Cows.
1, prime; 2, choice; 3, good; 4, medium; 5, common.

III. Bulls.
(*a*) Beef.
1, choice; 2, good; 3, medium.
(*b*) Bologna.
1, choice; 2, good; 3, medium; 4, common.

IV. Cutters.
(*a*) Steers.
(*b*) Cows and heifers.

V. Canners.
(*a*) Steers.
(*b*) Cows.
(*c*) Bulls.
(*d*) Calves.

VI. Veal Calves.
(*a*) Light weight, 90-120 pounds.
1, choice; 2, good; 3, medium; 4, common.
(*b*) Handy weight, 120-180 pounds.
1, choice; 2, good; 3, medium; 4, common.
(*c*) Medium weight, 180-220 pounds.
1, choice; 2, good; 3, medium; 4, common.
(*d*) Heavy weight, 220 pounds and up.
1, choice; 2, good; 3, medium; 4, common.

Feeding Cattle

I. Feeder Steers and Heifers.
(*a*) Heavy, 1,000 pounds and up.
1, selected; 2, choice; 3, good; 4, medium.
(*b*) Medium weights, 800 pounds to 1,000 pounds.
1, selected; 2, choice; 3, good; 4, medium; 5, common.
(*c*) Light weights, 800 pounds down.
1, selected; 2, choice; 3, good; 4, medium; 5, common.

II. Feeder Cows.
1, choice; 2, good; 3, medium; 4, common.

Stock Cattle

I. Stock Steers.
(*a*) Heavy weight, 700 pounds up.
1, choice; 2, good; 3, medium; 4, common.
(*b*) Medium weights, 600 to 700 pounds.
1, choice; 2, good; 3, medium; 4, common
(*c*) Light weights, 600 pounds down.
1, choice; 2, good; 3, medium; 4, common

II. Stock Cows.
1, choice; 2, good; 3, medium; 4, common.

III. Stock Heifers.
1, choice; 2, good; 3, medium; 4, common.

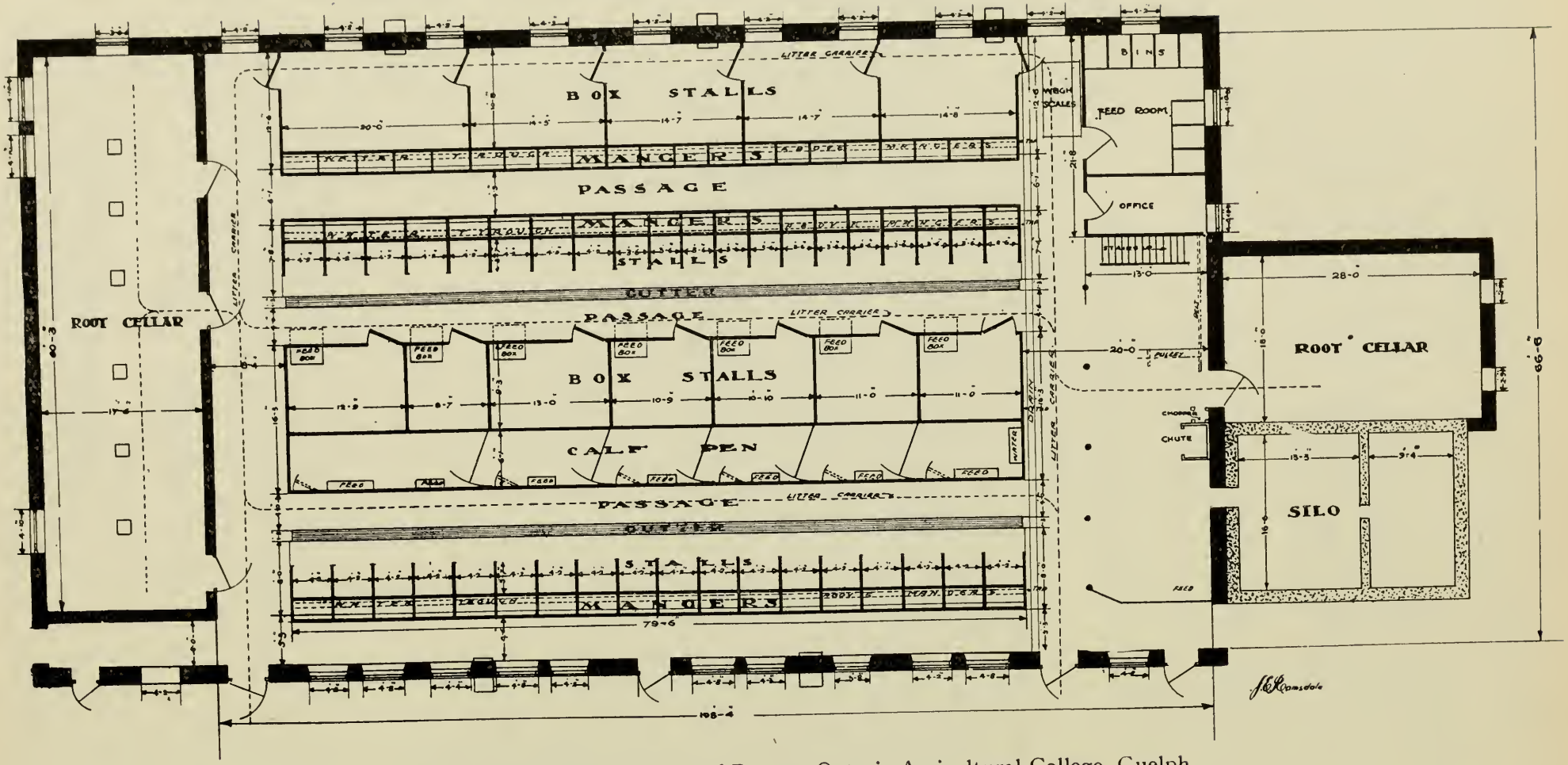
IV. Stock Calves.
1, selected; 2, choice; 3, good; 4, medium; 5, common.

Stables and Stabling

A a general thing, there is not much difficulty experienced in laying out a stable for beef cattle. Dryness, free ventilation and plenty of light are the main essentials. Warmth is not particularly important. The stable should be located on high, dry ground and should supply from 600 to 800 cubic feet of air space for each mature animal. From four to five square feet of glass per cow in windows hinged at the bottom and opening in about twelve or fifteen inches at the top ensures plenty of light, and this arrangement prevents drafts. A good ventilating system is arranged by building cement or plank tubes up the outside of the wall about six feet high with an inside opening nine by eighteen inches. This tube goes through the wall at, or just above, the floor and the opening is covered inside with a sheet iron deflector set out about three inches from the inside of the wall to prevent drafts. Sufficient of these tubes should be placed on each side of the stable to supply eight square inches of inlet per mature cattle beast. Then, a satisfactory outlet system may be arranged over the centre of the barn with air-tight tubes giving twice the outlet space provided by the inlets or, by the use on opposite corners of the stable, of 18-inch galvanized pipes coming right down through the roof of the barn and ceiling of the stable and extending to within about eighteen inches of the floor. These pipes should have a large damper located just under the stable ceiling.

For beef cattle, cow stalls should be at least three and one-half feet wide and the stands from four feet seven inches to five feet nine inches in length, the former for the younger cattle and the latter for the larger cows. Mangers generally take up about two feet of space, wider at the top than at the bottom and may be made with cement with the corners rounded. It is well to slope the stall platform one inch to one and one-half inches from manger to gutter and to arrange the mangers so that they are about two inches higher than the front of the stall platform. Gutters behind the cattle should be from sixteen to eighteen inches wide and there should be a drop of about six inches from the stall platform to the bottom of the gutter and of about four inches from the passage floor to the bottom of the gutter. It is well to slope all gutters from one to two inches in every fifty feet.

The barn may be laid out with a central feed passage or a central litter passage, according as to whether the cows face in or out. Such a passage should be from six to seven feet wide and a single feed passage in front of the cows should be five feet wide.



Plan showing the layout of Beef Barn at Ontario Agricultural College, Guelph.

No beef cattle stable is complete without a large number of box stalls. Stalls from nine to ten feet square are big enough for a cow with her calf, or to handle a number of young calves together, although a few larger stalls, particularly for feeding steers, are highly desirable. Box stall partitions should be from four and one-half to five feet high.

All floors should be of cement, about six inches thick, and passages should have a rough finish to prevent cattle slipping. It might be said in this regard that the use of a little ground limestone sprinkled in the passages each day will, to a great extent, obviate the danger of slipping.

The height of the ceiling is important and it will be found that in order to get a sufficient circulation of air, it should be from eight and one-half to nine feet.

For the breeding herd a comfortable tie is necessary, and for heavy cattle nothing is more satisfactory than double chain ties. This means, chains fastened to rods on both sides of the stall.

In most basement stables the walls are cement or stone. These may be damp, and if so, would be improved by studding up on the inside and lining with boards to make a dead air space. The best wall is one that is studded up on a cement base and double boarded, with paper between.

We are publishing herewith a plan of the beef cattle stable at the Ontario Agricultural College. It will be noted that there is arranged, behind one of the rows of cows, a calf pen, running the entire length of the stable. This pen is a little over six feet wide and is divided into a number of stalls by gates. It would be better if this run were a little wider, say eight feet. This works out very well indeed as an arrangement for handling calves which are nursing cows which stand in the stalls just across the passage. Then, for the cows in the other row, which may be nursing calves, there are seven box stalls which may be used for these calves or for maternity boxes, and at the opposite side of the barn, five large box stalls in which steers may be fed or they may also be used for maternity boxes. Most of these tied stalls are a little wider than previously suggested and there are some odd dimensions for the box stalls, but this is a remodelled stable and will give some idea of a fair layout where a large number of beef cattle are kept, steers fed, and pure-bred heifers developed. A study of the plan will prove of value to anyone desiring to remodel his stable.

As pointed out elsewhere in this bulletin, expensive stables are not necessary for fattening cattle. Neither are they imperative for the breeding herd. Dry, open sheds will prove sufficient shelter for fattening steers or for the development of young breeding cattle under average conditions, but it is well to plan a system that will permit of tying the older breeding cows, and allowing the calves to nurse only two or three times per day as the case may be.

SANITATION

In order to prevent disease and assist in maintaining the health of the herd, all stables should be cleaned at least once per day and preferably twice. It should be the practice of the careful herdsman to thoroughly clean and disinfect the stable before the cattle come in, in the fall, and to hold all newly purchased cattle in quarantine, away from the rest of the herd, until one is sure that they are free from disease. A good plan is to thoroughly whitewash the entire inner surface of the stable, using a five per cent. carbolic solution. This may be done in the fall just before the cattle are stabled, and the whitewash may be applied with a sprayer after the stables have been thoroughly swept down. Besides this, a liberal daily use of fresh lime or some coal-tar disinfectant

in gutters and passages while the cattle are in the stable should be resorted to. If any contagious disease has developed in the barn, in order to clean it up, it is wise to remove all cattle and thoroughly scrub all the internal surfaces of the stable with a solution of Gillett's lye. It is well, too, where such can be arranged, to lay out the farm yard so that the cattle, when out, are kept away from the piled manure which may carry infection from diseased animals. Regularity in feeding, making changes gradually, and studying the needs of the individual animals will obviate most of the dangers of digestive troubles.

KILLING LICE

While thoroughly spraying the stables may rid them of cattle lice, most herds become infested during the winter months. The best method we have found of clearing cattle of vermin is to rub sabadilla powder into the skin by brushing against the hair. Sabadilla may be purchased at any drug store, and usually one or two applications are sufficient. If the cattle are badly infested, a second application from a week to ten days following the first, may be necessary. Some report good results from dusting a mixture of four parts cement to one part hellebore over the animals and working it into the skin by combing or brushing the hair the wrong way. Others wash with some coal tar disinfectant, and this gives very good results, but it is more difficult to perform than the dusting.

It is not the purpose of this bulletin to discuss diseases common to cattle. Care should always be taken in changing feed and all changes should be gradually made. The cattleman should avoid turning his stock on wet rape or wet clover, and should accustom them to eat these feeds gradually, in order to prevent bloat. He should, in purchasing new stock, always take the precaution to know something of the health of the animals bought. Tuberculosis and contagious abortion are the two worst diseases affecting the beef cattle industry and, where found, should be isolated and all precautions taken to prevent their spread. The medicine chest should always contain Epsom salts, linseed oil, castor oil for the calves, tincture of iodine to be applied to sores, carbolized vaseline for caked udders, and a little ginger and *nux vomica* for digestive troubles. Usually from one to three pounds of Epsom salts will purge an animal, and one to two pints of linseed oil will act as a laxative. An ounce of ginger given with any purgative prevents griping, and two to three drams of *nux vomica* three times daily may be used along with Epsom salts for impaction. For ordinary bloat, from two to four fluid ounces of turpentine in a pint of linseed oil may be given and the dose repeated in an hour if relief does not follow. For bad cases of any disease, it is always well to call the veterinarian.

BEEF RINGS OR MEAT CLUBS

As a means of securing a summer fresh meat supply for the farm, beef rings have become fairly popular in Ontario. The beef ring is essentially a co-operative concern and may be formed by any group who come together where there is a need for a ring or club. It is not necessary to publish here constitution and by-laws, which may be obtained from Circular No. 39, Co-operation and Markets Branch, Ontario Department of Agriculture. Clubs may be composed of from sixteen to forty members, but most are based on the 20-share plan, which means twenty members and twenty beeves killed. The next most popular plan is the 16-share plan. Most rings begin operations in May and continue until each member has supplied a beef. The club appoints a butcher or manager and also inspectors, who pass upon the suitability of the animals offered. The animal, not beyond a two-year-old, is usually delivered to the place of slaughter at least twelve hours before killing and is slaughtered in the late afternoon of the day previous to the distribution; around a 400-pound carcass is the approved weight. The following two charts show the methods of cutting for a 16- or 20-share ring. For further information, apply for Circular No. 39.

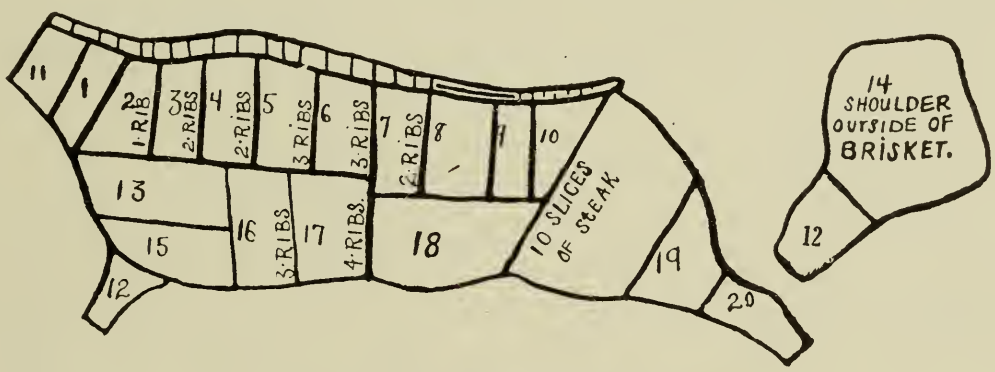


Chart for Twenty-share Beef Ring.

The two sides of the carcass are cut alike, each member receiving a roast, boil and a share of steak, according to chart above; that is, the first and eleventh members on the list receive the roast marked one and the boil marked fourteen, with one slice of steak; the next week, these two members receive the roast marked two and boil marked thirteen with slice of steak, the tenth and twentieth members taking their turn with roast one and boil fourteen.

Members	Roast	Boil	Steak
Nos. 1 and 11	1	14	1
" 2 and 12	2	13	2
" 3 and 13	3	19	3
" 4 and 14	4	16	4
" 5 and 15	5	17	5
" 6 and 16	6	18	6
" 7 and 17	7	15	7
" 8 and 18	8	12	8
" 9 and 19	9	20	9
" 10 and 20	10	11	10
" 21	Head, etc.		

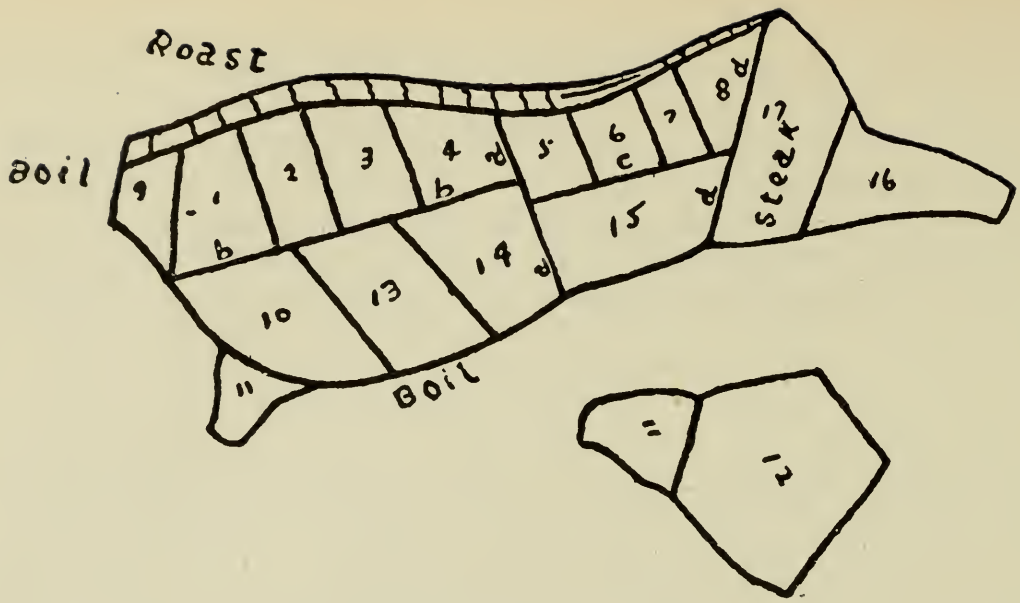


Chart for Sixteen-share Beef Ring.

In a 16-share ring, each half being cut up, it is divided among the first eight persons, giving each a roast, a boil and a slice of steak, as indicated for the 20-share ring.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

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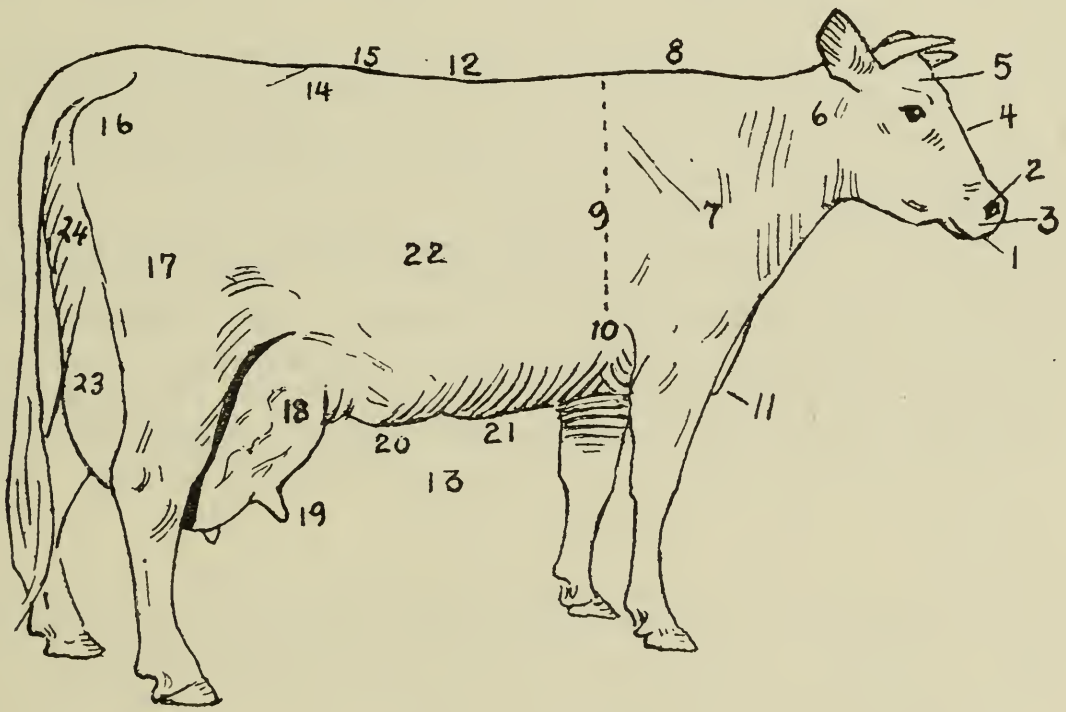
Dairy Cattle

J. C. Steckley, B.S.A., Associate Professor of Animal Husbandry

Dairying in Ontario is one of the largest industries, totalling annually over seventy million dollars. Like all industries in a new country, dairy farming has gone through a number of changes. There have been periods of depression which have caused farmers to change to other lines of farming, and also periods of dairy prosperity when many have changed from other branches of farming to take up dairying. Twenty-five years ago, most Ontario farmers did not specialize.



Points of a Dairy Cow

1. Mouth	9. Heart Girth	17. Thighs
2. Nostril	10. Chest	18. Udder
3. Muzzle	11. Breast	19. Teats
4. Face	12. Topline	20. Milk veins
5. Forehead	13. Underline	21. Milk wells
6. Neck	14. Hook bones	22. Middle
7. Shoulder	15. Loin	23. Rear udder
8. Shoulder top or withers	16. Pin bones	24. Escutcheon

Dairying was a side line on most mixed farms except in some localities where dairy farming was considered a specialty in cheese-factory districts. To-day it

is a specialized type of farming, supplying milk or cream to several different kinds of dairy plants. Twenty-five years ago the buttermaking was largely in the hands of the farmers' wives; to-day it is done largely in creameries. Twenty-five years ago the grade Shorthorn cow was the main source of milk; to-day she is largely replaced by the specialized breeds of dairy cattle. Up until a few years ago the milk for town and city consumption was supplied by farmers living in the near vicinity, but as the cities grew and transportation facilities were perfected, the area devoted to this branch of dairying spread farther and farther afield until now the milk for some of our larger cities comes from districts which not so long ago knew only the cheese factory as a market for their milk.

Ontario agriculture is gradually changing from generalization to specialization. In 1900, the general run of farmers kept a few cows and made butter and raised calves to fatten as beef, except in some of the oldest dairy districts where the milk was sent to the cheese factory. To-day, through southwestern Ontario this is not the case. The farmers are specializing. Beef-raising is specialized and is separated from dairying. The farmer who is dairying keeps cows of the specialized dairy breeds and shows little or no tendency to raise beef as a side line.

The following table will give some idea of the number of dairy cows in the province during the past twenty-five years:

1900	976,124 cows	1920	1,170,010 cows
1905	1,106,984 "	1922	1,235,665 "
1910	1,052,796 "	1923	1,265,965 "
1915	1,022,518 "	1924*	1,203,527 "

While these figures only show an increase of around 26 per cent. in the number of cows kept, the dairy industry has grown much more than indicated, showing that the average production per cow has increased through the change from dual-purpose to specialized dairy breeds and the change from ordinary mixed farming to specialized dairy farming.

In 1900, 127,789,543 pounds of cheese were produced valued at $13,120,887, and 9,041,468 pounds butter valued at $1,819,290. In 1920, 92,847,769 pounds of cheese valued at $24,615,290; 37,148,898 pounds of butter valued at $21,245,-664; condensed milk and powdered milk valued at $14,000,000; ice cream, skim-milk, buttermilk, and cream cheese valued at $11,000,000; farm dairy butter and milk used on farms and in towns and cities valued at $35,000,000; making a total of $105,860,954 worth of dairy products produced in Ontario. In 1922 this total dropped back to $70,085,238, due largely to the drop in the price of dairy products.

A great deal of the increase has been due to the change from summer to all-the-year-round dairying. In 1900, the average Ontario cow was estimated to give 3,000 pounds of milk annually; in 1925, the average Ontario cow gives 4,000 pounds, which is still much too low, as will be seen in comparing the production of our cows with those of other countries.

The average yearly production per cow for some of the countries:

Netherlands	7,585 pounds	Denmark	5,666 pounds
Switzerland	6,950 "	Germany	4,350 "
Great Britain	5,934 "	Ontario	4,000 "

Dairy farming, at the present time, is a highly competitive business. Dairy products are rather low in price compared with other things, and unless a man is willing to go slowly and be content with small profits, it is doubtful whether

*In 1924 the estimated number of cows kept mainly for beef purposes was 100,982. Many of these were probably included in previous years as "milch cows."

he should not go into other lines of farming. To the man who is interested in the business, who likes cows and is interested in feeding and constructive breeding work, there is probably no other line of farming with as great possibilities.

The successful dairy farmer must have good cows. He must, therefore, be acquainted with dairy type. This is absolutely necessary in either buying or breeding. He should understand breeding work. No other side of dairy farming is as interesting as trying to produce the champion cow in the ring or in the test, or a combination of both. He must employ business methods, as the business will not run on sentiment. Feed and milk should be weighed, the Babcock test applied and the non-producing cow discarded. He should know how to feed in order to get the most from the cows and still have an economic ration. After the dairy product is produced there is still the marketing end, which, at this time, has to be studied very carefully.

Milk as a Food

Among the most important discoveries made in recent years have been the contributions of nutrition experts showing the very high value of milk as a food. These investigations have shown that milk is very rich in vitamines which are essential to the normal growth and well-being of humans. As most of the foods used for children are low in some of these vitamines, it is essential that they receive an abundance of milk and milk products in order to grow and develop sturdy bodies. Milk is also rich in protein and mineral matter, particularly lime and phosphates, both of which are necessary to promote growth, and are not found in the ordinary foods consumed by man. Besides this, milk also contains fat and milk-sugar, which are valuable in the diet as energy producers. Due to this high quality of milk as a food, combined with the economy with which it is produced, the number of dairy cattle continues to increase.

That the cow is the most economical producer of human food is shown when compared with that of the meat-producing animals. For every 100 pounds of digestible food consumed, the cow produces in milk 18.0 pounds of edible dry matter. The pig, the most economic of the meat-producing animals, yields 15.6 pounds of edible dry matter; the calf, 8.1 pounds; the steer, 2.8 pounds; and the sheep, 2.6 pounds. Furthermore, a cow yielding only 8,000 pounds of milk produces annually, in her milk, 56 per cent. more protein, 30 per cent. more fat and sugar, and 19 per cent. more mineral matter than in the body of a two-year-old steer weighing 1,200 pounds.

DAIRY TYPE

Dairy type differs considerably from beef type. In the case of beef animals the ability to lay on flesh is the first essential, while in a dairy cow the ability to produce milk is of most importance. When judging or selecting a dairy cow, one must always bear in mind this function of economic production. As a manufacturing plant, the cow must be able to eat and digest an abundance of raw material; she must have the ability to thoroughly assimilate this raw material and convert it into blood constituents; she must have the necessary apparatus for secreting this material in the form of milk; and she must have the disposition to do so. Thus the cow must have:

1. A well-developed digestive system.
2. A strong constitution, which means an efficient circulatory and vital system.
3. An active mammary system.
4. Marked dairy temperament.

A well-developed digestive system is indicated by a large barrel. This is obtained by length of body, width in the rear part of the barrel and general depth throughout. Consequently, a dairy cow must be long from the shoulders to the hips, wide across top from hip point to hip point, and must be deep from the rear of the loin to the base of the abdomen. This width at the hooks should be carried well forward, giving a wide loin throughout. The loin should be level, with the rear ribs well sprung. The rear ribs should be long, broad, flat and wide apart.

A strong constitution is indicated by great chest capacity, which demands depth from top to bottom of the body just back of the forelegs, thickness through the body at this region, width on the floor of the chest and fullness in the fore-flank. The fore-ribs should spring out quite strongly, and descending, obtain their greatest width one-third to one-half way down the body, thus giving ample room for heart and lung development.

With the width of fore-rib, a prominence or roughness of the shoulder should be avoided. The shoulder must lie smoothly and the dorsal vertebrae should extend above the points of the shoulder blade. Any prominence of shoulder indicates too much flesh between the shoulder blade and the front rib, and this development of flesh is not desired. In dry cows that are well fed in preparation for their next lactation period, a breadth across the top of the shoulder naturally develops due to the fat deposited beneath the shoulder blade, so allowance must be made between dry cows and those milking. A large well-developed nostril is another indication of lung development.

To secrete milk a cow must have a well-developed mammary system. The udder should be large and of good quality. It should be long between the rear and forward attachments, extending high between the thighs. It should be broad and well filled in the rear and forequarters, with no noticeable division between the quarters. It should also be well balanced; each quarter should be the same size. The sole or bottom of the udder should be level and run well forward on the abdomen. In quality the udder should be soft, pliable and elastic. A coarse, firm, non-elastic udder is an indication of too much fibrous non-secreting tissue. The teats should be placed squarely in the centre of each quarter. They should be large enough for comfortable hand-milking. Very short teats are objectionable, and there is no advantage in undue length and size. The teats should be regular in shape and of fair thickness.

The milk veins, or the large abdominal veins running forward from the udder upon the lower surface of the abdomen, carry the blood from the udder back to the heart. These should be long, large, tortuous and branched and should enter the abdominal wall through large orifices called the milk wells. The size and development of these milk veins and milk wells are indications that a large flow of blood is passing through the udder and consequently there is opportunity for a large milk secretion.

Dairy temperament is absolutely essential in a dairy cow. This is indicated in many ways. It is shown by a natural leanness throughout. The head should be clean-cut and long from the eyes down to the muzzle. The forehead should be broad, the eyes prominent, full and placid, the neck long and lean. The spine should project above the shoulders at the withers and should show prominence and openness right down the back. The dairy cow should show a freedom from meat and meat-carrying tendencies, so a light loin, a thin thigh and an open twist are always looked for. The rear ribs should be broad, flat and widely spread.

Quality is of utmost importance in a dairy cow. This is evidenced in a loose, mellow, fairly thin skin, fine, soft, bright, oily hair, and smooth, fine, clean bone. The cow should also have a fineness about the head, a fine horn, a freedom from coarseness about the shoulder or hooks, and a fine, slim tail. A coarse cow, lacking in quality, is almost certain to give smaller returns for the feed consumed.

The general appearance of the dairy cow also plays an important part in her make-up. Most dairymen prefer a large cow. All animals should have a straight, strong top line from head to tail. This adds to their appearance and helps in selling the individual. Weak backs and drooping rumps are particularly objected to. A cow with a weak back is less active and tires more readily and consequently is a less useful cow. A drooping rump is naturally accompanied by an udder that lacks development in forequarters. The rump should also be wide at the pins in order to give more width for attachment of udder behind. There is a direct correlation between shape and attachment of udder and the conformation of the rump of a cow. The length of attachment of udder is determined by the length of rump. A short rump necessitates a short udder.

A dairy cow should also be deep and fairly low set. The long-legged cow is usually shallow in body and much harder to feed economically.

A dairy cow should show considerable style of carriage. She should carry her head erect and have an alert and graceful appearance. She should be well-proportioned so that all parts are in harmony, and should stand well on her legs. Along with this active and alert bearing she should show no signs of any viciousness and should not be easily alarmed. She should have full confidence in her master.

Besides all this, she should show considerable femininity. This term stands in opposition to that of masculinity as applied to males. Fineness in the face and contour of the head, lightness in the horn, fineness in the neck and lightness in the brisket and shoulder are all feminine characteristics. Femininity, besides being a guide to milk production in a cow, is a sign of a regular and reliable breeder as well.

SCALE OF POINTS	Possible Score
Estimated weight ..... pounds	
Form—Wedge-shaped as viewed from front and top; straight top line, and great depth of barrel	5
Quality—Hair, soft and fine; skin, of medium thickness, mellow and elastic; secretion, yellow; bone, fine and clean	6
Style—Active, vigorous, showing strong character; temperament, inclined to nervousness, but not irritable or vicious	5
Muzzle—Broad and clearly defined; mouth and nostrils large	1
Eyes—Large, prominent, clear and placid	1
Face—Lean and somewhat long, fine between muzzle and eyes	1
Forehead—Broad	1
Ears—Of fine texture, and medium size; secretion, abundant	1
Neck—Thin, rather long, fine and clean at junction with head; no noticeable amount of dewlap	3
Withers—Lean and sharp; vertebrae, somewhat higher than blades	2
Shoulders—Light, good distance through from point to point, but sharp on top; smoothly blended into body	2
Legs—Well apart, straight and short; shank, fine and smooth	2
Chest—Deep, full between and back of fore-legs, no depression behind shoulder blade	6
Ribs—Long, broad, and wide apart; well sprung; giving a large, deep barrel	10
Back—Lean, straight, and open-jointed; sharp chine and broad loin	6
Hooks—Wide apart	2
Rump—Long and wide	3
Pin Bones—High and wide apart	1
Thighs—Thin	2
Legs—Straight and set well apart; shank, fine and smooth	2
Escutcheon—Spreading over thighs and extending far upwards	2

SCALE OF POINTS—*Continued*

	Possible Score
Tail—Long and fine, terminating in a switch of fine hair	1
Udder—Long, wide, deep, but not pendulous, firmly attached, extending well up behind and far forward; quarters even and free from fleshiness	25
Teats—Large, uniform, and evenly placed	5
Milk Veins—Large, long, crooked and branching	3
Milk Wells—Large and numerous	2
Total	100

THE BREEDS OF DAIRY CATTLE

The Holstein-Friesian

The native home of this breed is in the province of Friesland, in Holland, and the province of Holstein, in Germany, where they have been bred for centuries. Even back in the flourishing days of the Roman Empire, the district

Pioneer King Toitilla—46493.
Holstein-Friesian Herd Sire at the Ontario Agricultural College.

now known as Holland was noted for its black-and-white oxen and cheese. A race of cattle with many of the present characteristics of the Holstein-Friesian has doubtless remained pure for 2,000 years. These cattle have spread all over the world and were doubtless used in the building up of many of our present-day breeds. They have been known by the names of "Holland," "Dutch-Friesian," "Dutch Holstein," "Netherland," and "Holstein-Friesian." A little more than a half-century ago, large black-and-white cattle were brought to America under two names, Dutch Friesian and Holsteins, and were advertised as separate breeds and championed by different breed associations. As these cattle were so much alike, the two associations were merged into one and the name Holstein-Friesian adopted for this breed in America.

In all, 7,757 animals were brought into the United States between 1852 and 1905. Since the latter date no animals of the breed have been brought in from

Europe on account of the danger of introducing infection of foot-and-mouth disease. From this 7,757 head imported into the United States, the breed has developed as we have it to-day in North America, as the foundation for the breed in Canada has come entirely from the United States. The breed, on this continent, is a little more inclined to be extreme dairy type than when found elsewhere, due, no doubt, to the isolation and the extensive systems of testing adopted by the breed associations in Canada and the United States.

While the foregoing is true regarding the registered animals of the breed, it is altogether likely that the first representatives of the breed to reach this country came with the early Dutch settlers in Pennsylvania and New York States.

The colour of the Holstein is black and white. These colours are distinct with no tendency to blend. Only rarely a red-and-white calf is dropped from pure-bred parents, but it is not eligible for registration. They are the largest

ELMCREST ORMSBY FAYNE—49090.
Combining type with production.
728.8 pounds of milk, 38.11 pounds butter in seven days.

of our dairy breeds, the mature cows weighing from 1,100 to 1,500 pounds and occasionally as high as 1,700 pounds. A mature bull should weigh from 1,800 up to 2,500 pounds.

The Holstein-Friesian is famous for milk production but has been criticized for the low percentage of butter-fat. As a breed this is probably true, but the best breeders have been guarding against this and have been successful in building up strains which are exceptionally satisfactory in this respect. Production has been the chief consideration in developing this breed in America and there has been a tendency on the part of a number of breeders to sacrifice type, to a certain extent, and, as a consequence, the breed has not as much uniformity in conformation as some of our other breeds. At the present time this difficulty is being gradually overcome.

While showing excellent dairy type, the Holstein-Friesian is somewhat rougher than most breeds of dairy cattle. They are, however, very open in

conformation, with large, capacious udders which sometimes show lack of balance and a tendency to be pendulous.

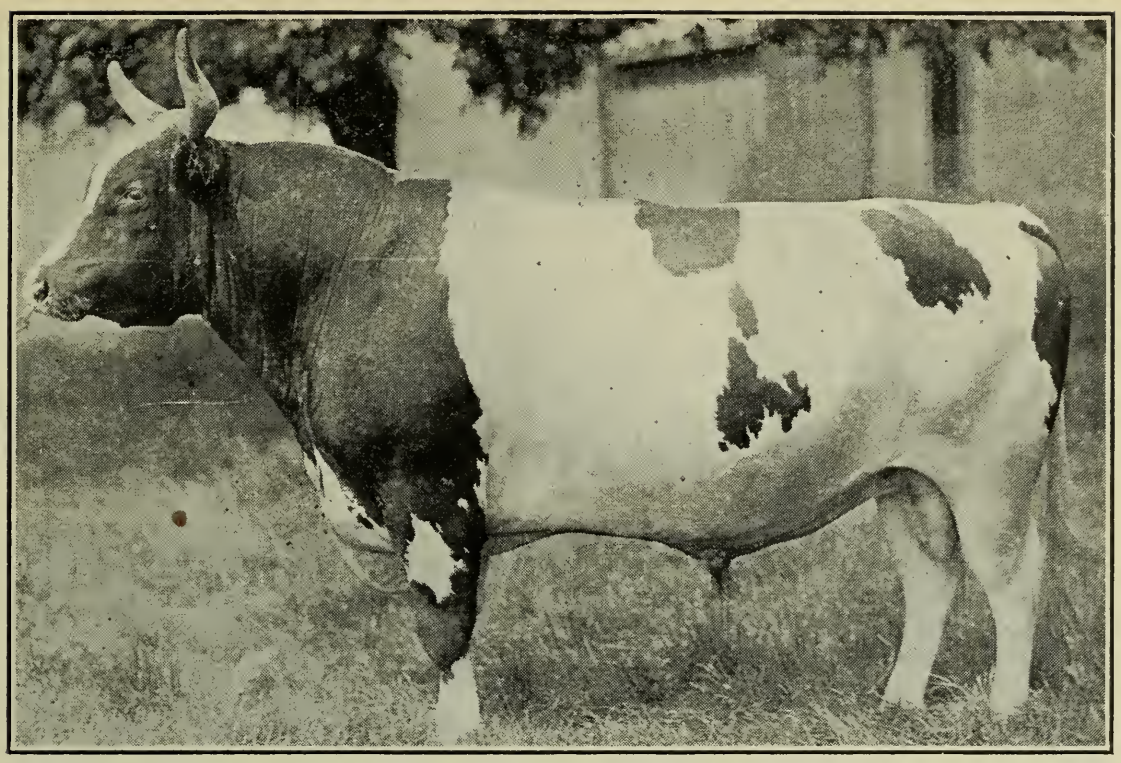
As a producer of large amounts of milk, the Holstein-Friesian leads all other breeds. Practically all the world's records, both butter and milk, are held by this breed. In Canada, at the present time, there are ten cows that have produced more than 1,000 pounds of butter-fat in the year, and five that have produced over 30,000 pounds of milk in the year. The present world's record cow for milk production is Segis Pietertje Prospect with 37,381 pounds of milk in a year, while the Canadian cow, DeKol Plus Segis Dixie, holds the yearly butter-fat record for the breed with an annual production of 1,349.35 pounds.

DeKol Plus Segis Dixie—295135.
World's Champion strictly official Holstein cow.
33,463.6 pounds milk, 1,687.04 pounds of butter.

The Ayrshire

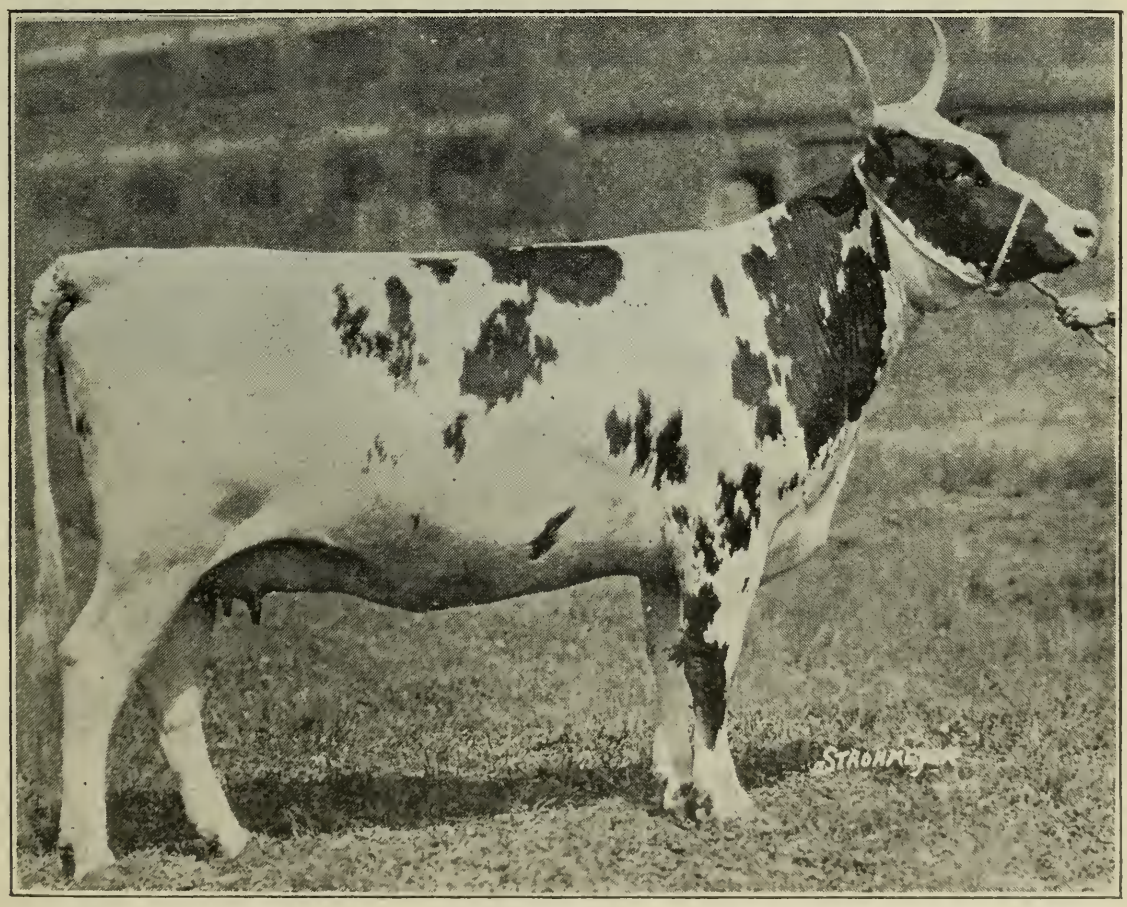
In comparison to other breeds of dairy cattle, the Ayrshire may be said to be the youngest breed. The breed takes its name from the county of Ayr in southwest Scotland, where it had its origin. In 1750, the cattle in this region were described as undersized, ill-fed, irregular, and as producing little milk. These cattle were improved largely by crossing with better-developed breeds. Historians differ as to the breeds used in this regard, but it is evident that the blood of Teeswater cattle, later known as Shorthorns, was among the first used. This cross produced a rather beefy animal, and, later, cattle from Holland and the Channel Islands were introduced to improve the milking qualities. Some early writers also mention the introduction of West Highland, Hereford and Devon into some of the herds, but how much of this blood has been handed down in those animals that formed the Ayrshire is not known.

The county of Ayr is rather rough. Though cold in winter, the climate is not hot in summer. There is plenty of rain which makes pasture abundant. Thus the Ayrshire was developed under cool, rugged conditions where grazing ability was essential.



Victoria's Bunty Lad—65171.
Ayrshire Herd Sire at the Ontario Agricultural College.

The Ayrshire ranks as a middle weight dairy breed. Mature cows weigh from 1,000 to 1,200 pounds, and bulls from 1,500 to 1,800 pounds, and sometimes



Burnside Blossom Andrietta—74206.
Noted show-winning Ayrshire. Shown in heifer form.

more. The colour of the Ayrshire is brown and white, the brown ranging from very light brown to almost black. The predominating colour at the present time is white with brown spots. They are distinct and do not blend to form a roan.

For a number of years the plump form was held in the endeavour to retain the beef qualities along with the dairy, but the present type is larger and more angular. The straight back, level rump, long rear-quarters and symmetrical udder are being retained, and the short teats of the past are being developed beyond the point of criticism. The striking character of the Ayrshire is the head. While rather short for dairy type, it is clean-cut with good width between eyes and also great width at the poll. The horn is rather large and usually curves outward and upward and in most cases slightly backward.

NELLIE OSBORNE OF ELMSHADE 16TH—71910.
Canadian Champion Milk and Fat producing Ayrshire.

Cows of this breed are not noted for exceptional milk records, but, as a breed, are uniform producers of milk of good quality and, at the same time, produce very economically. As a breed, the Ayrshire will rank second to the Holstein for milk production, with a higher percentage of butter-fat.

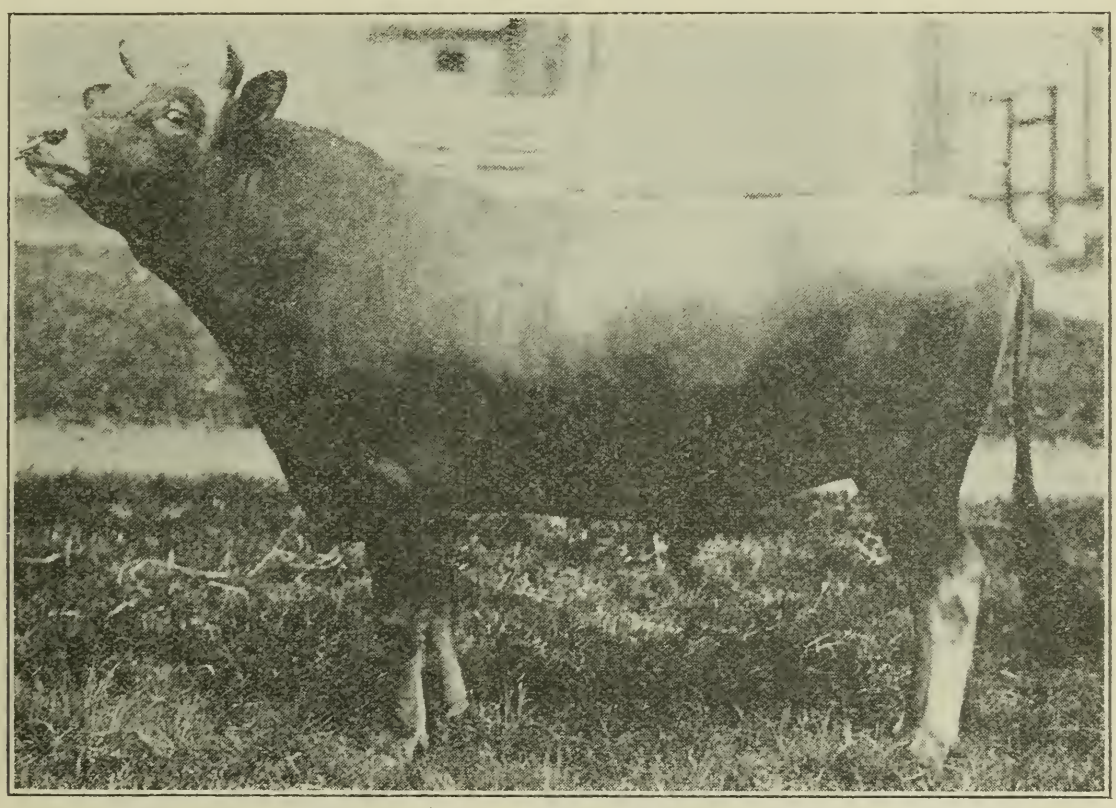
Early in the nineteenth century, Ayrshires were brought to Canada, and soon after herds were established in New England. Large numbers have been brought over since that time and they are now distributed fairly well over Canada and the United States. In Canada, they stand second in numbers; in the United States, fourth. In Canada, they are most popular in Eastern Ontario and Quebec.

The highest record for the Ayrshire breed in Canada is 22,566 pounds of milk, with only one record over 20,000 pounds. Up to the present there are no

1,000-pound-fat producers in this breed. The highest record for the breed in milk production is held by Garclaugh May Mischief with 25,329 pounds of milk in a year, while Lily of Willowmoor holds the record for butter-fat for the year with 955.55 pounds of butter-fat. Nellie Osborne of Elm Shade 16th holds both the milk and fat record for Canada, with 22,566 pounds of milk and 901 pounds of butter-fat.

The Jersey

The Jersey originated on the island of Jersey, which is the largest of the Channel Islands situated off the north coast of France. These islands belong to Great Britain, but are populated by people of French origin. Jersey island totals 31,000 square miles, of which 25,000 are tillable. The population of



Rower's You'll Do Warrior—20668.
Jersey Herd Sire at the Ontario Agricultural College as a two-year-old.

60,000 is engaged largely in truck-gardening, but a great deal of attention has been paid to the Jersey cow. There are about 10,000 cows on the island, or one for every two and a half acres of cultivated land. The forage on Jersey is rather scanty and the cattle are tethered rather than run loose on pasture. The cattle are handled very carefully; grass and vegetables form the main part of the ration, with very small amounts of grain.

In 1763 and again in 1789, laws were passed on the island prohibiting the importation of cattle except for immediate slaughter. This was done to safeguard the health of the cattle on the island, but has been of even greater value in preserving the purity of blood and permitting the development of one of the most noted breeds of cattle in the world.

Jersey cattle were brought to America at the beginning of the nineteenth century. At that time they were known as Alderney cattle. The first im-

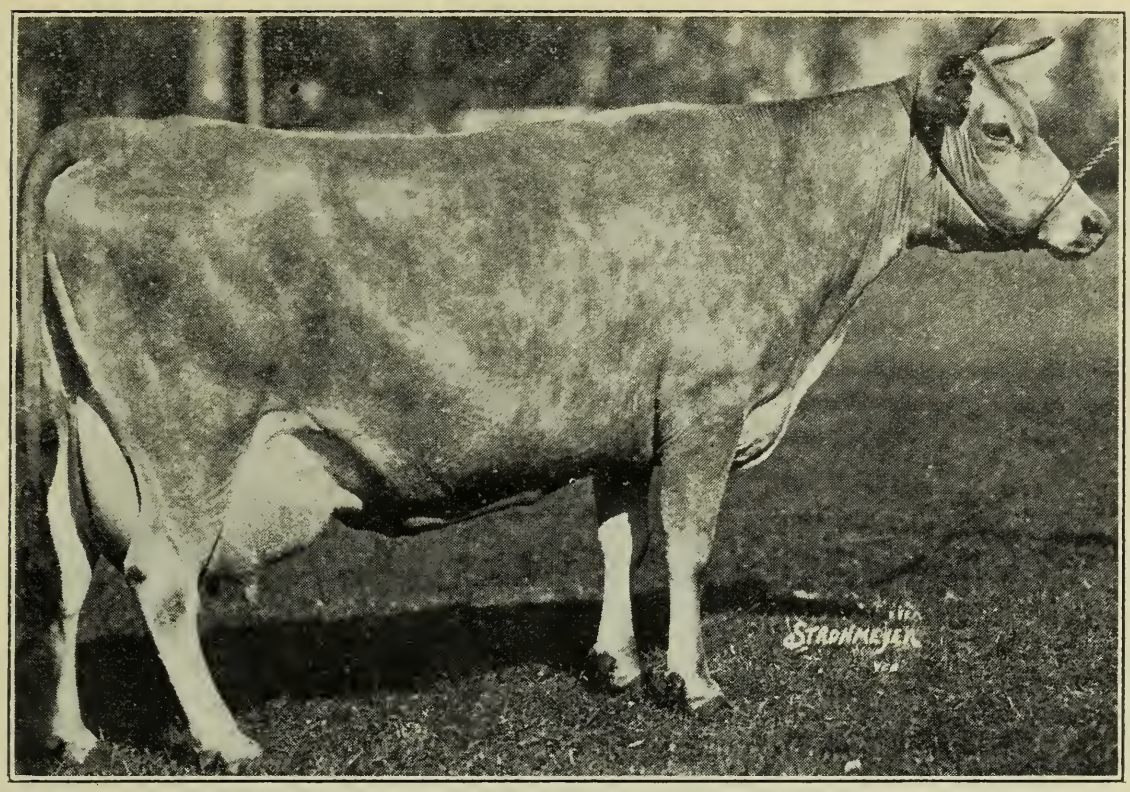
portation of real importance was brought to Canada about 1870 and since that time numerous importations have been brought over to assist in laying the foundation in America. The Jerseys developed in this country are larger and rougher, with less refinement than those raised on the island, due, no doubt, to different methods of feeding. This has led to the development of two types, known as the island type, which is considered the show-ring type, and the larger and rougher type, known as the American type.

The colour of the Jersey varies from a light silver grey to seal brown, almost black. The majority in this country are varying shades of fawn. White markings are sometimes seen and are not objectionable. The Jersey is one of the smallest of the dairy breeds, mature cows weighing from 700 to 1,000 pounds, while bulls vary from 1,300 to 1,700 pounds. The Jersey matures at an early

Brampton Seaside Lass—4671.
Champion Jersey Cow, National Dairy Show, St. Paul, 1921, and Royal Winter Fair, 1923.

age and is often bred at too early an age. She is a more refined and a more highly specialized dairy cow than found in any other breed. While not noted for giving large quantities, the milk is very rich in fat, averaging over five per cent. The fat globules are large, and, before cream separators came into operation, the milk was noted for the easy separation of the cream. The dairy products are highly coloured for this breed and a particularly firm texture is noted in Jersey butter.

In Canada, the Jersey stands third in point of numbers, but is very popular as the family cow and for specialized trade. While only a small breed, yet some excellent records are shown. Two cows in Canada have given over 1,000 pounds of fat in a year, Eminent's Martha of St. Omer and Brampton Dark Kate. The record Jersey cow of the world is Darling's Jolly Lassie, with 1,141 pounds of butter fat in a year.



EMINENT'S MARTHA OF ST. OMER—17168.
First Jersey cow in British Empire to exceed 1,000 pounds butter fat in a year. She held the Canadian record until captured by Brampton Dark Kate in 1925.

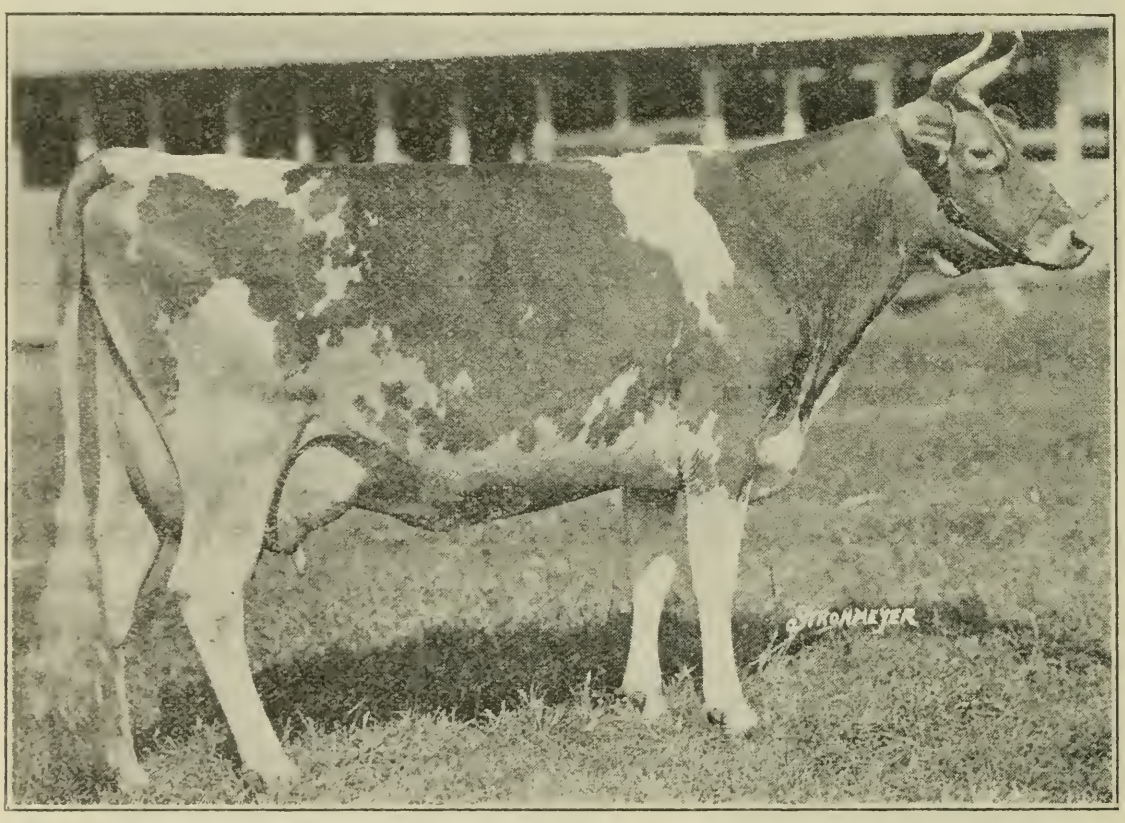
THE GUERNSEY

The Guernsey, like the Jersey, originated on the Channel Islands, and takes its name from the second largest island of the group. In earlier history there

MARTINDALE HOLLISTON.
Junior Champion Guernsey Bull, Royal Winter Fair, 1924.
Owned by Martindale Farms, St. Catharines.

seemed to be no distinction outside of the Channel Islands between the Jersey and the Guernsey breeds, as they were known as Alderney cattle, but for the past hundred years they have been known as separate and distinct breeds. Guernseys have become quite popular in the United States and are third in importance in respect to population. In Canada they are comparatively few in number although, during the past few years, they seem to be increasing in popularity.

They are considerably larger than the Jersey, as the cows would average around 1,100 pounds, and the bulls 1,600 pounds. In colour, the Guernsey is orange yellow which may be spotted with white. The muzzle is buff or flesh-coloured and is surrounded by light-coloured hair, as are also the eyes. The horns and hoofs are usually amber-coloured, though the horns may be nearly



Rosebud of Liberty Hills.
Grand Champion Guernsey Cow at the Royal Winter Fair, 1924.
Owned by Martindale Farms, St. Catharines.

white. The colour of the skin is a rich yellow and is a point much emphasized by breeders as indicating yellow colour of product. The udder is large and is noted for its fine texture and qualities. The skin is very mellow, thin and elastic and covered with moderately fine hair.

Guernseys are noted for the quality of their milk. While it is not as rich in fat as that of the Jersey, they give considerably more of it, and it is as highly coloured as that of the Jersey. The world's record for this breed is held by Countess Prue with 18,626 pounds of milk and 1,103 pounds of butter fat.

The French-Canadian

The French-Canadian can, more than any other breed, claim Canada as its home. Just when the first stock of this blood reached Canada is not absolutely known, though it is thought to be around 1620. The stock unquestionably

came from Northern France with the early settlers in the province of Quebec. While there was no attempt made for many years to keep the blood pure, it remains essentially so on account of the limited intercourse of the early pioneers with the none too friendly English-speaking people.

While sharing the pioneer life of the people who owned them, they developed a wonderful hardihood and yet retained a good measure of dairy qualities. They are rather small in size, being about the same size as the Jersey, the cows weighing 700 to 900 pounds, while the bulls weigh 1,200 pounds and up. They are somewhat coarser than the Jersey and do not show such refined dairy type. In colour they are ordinarily termed black, but in reality it is somewhat of a brownish black. They only give a moderate amount of milk, which is about the same quality as that of the Guernsey.

The Dutch Belted

Dutch Belted cattle are natives of Holland and are thought to have had the same origin in remote times as the Holstein. They are invariably black in colour with a pure white band encircling the body in front of the hips. This belt varies in width from twelve inches to thirty inches and sometimes takes in the fore part of the udder. They are much smaller than the Holstein. The cows weigh from 900 to 1,200 pounds, while the bulls average about 1,500 pounds. There are very few representatives of this breed in Canada.

The Kerry

The Kerry is the smallest breed of dairy cattle. Mature cows do not weigh over 500 pounds. This breed is a native of Ireland and is generally supposed to have descended from a small type of aboriginal cattle on that island, but nothing definite is known of its earlier history.

There are two types of the breed: the true Kerry, which are solid black in colour, and the Dexter Kerry, which are a blockier, lower-set type, and may be black, red or roan. They are very good producers with records as high as 10,000 pounds of milk in a year. They are rather slow maturing but are good grazers and yield a fair milk flow on very scanty rations.

DUAL-PURPOSE BREEDS

There are a number of breeds of cattle that are known as dual-purpose cattle; that is, they show a certain tendency toward beefing qualities as well as an indication of fair milk production. The breeds recognized as dual-purpose are the Red Polled, the Devon, and the Brown Swiss. Some strains of Shorthorns have been developed along dairy lines, and as most of them retain to a certain extent their beef qualities, they can rightly be called dual-purpose cattle.

The Shorthorn

The dual-purpose Shorthorn is the most popular breed of this type in Ontario. The development of the dairy Shorthorn took place largely in England and dates to the beginning of the nineteenth century. The most prominent breeder in this connection was Thos. Bates, who not only sought to improve the beef qualities of the breed but the milking qualities as well. In Canada and the United States, considerable work has been done to improve the milking qualities of the breed. These cattle do not all trace to the Bates foundation, as a large number have been developed from the beef strains in this country. Considerable variation is noticeable in these strains, some being very close to dairy type and showing little tendency to beef, while others adhere more closely to beef type and are not such good milkers. Up to the present time there does not appear to be

any definite standard and considerable difficulty has been experienced in having the strain breed true. Shorthorn cattle with the combination, however, are very popular in many districts where dairying as well as beef-raising is being carried on. It seems quite possible to get a fair combination of both milk and beef in this breed when hand-milking is practised and dairy characters are not overlooked in the selection of a sire.

The Devon

The Devon breed of cattle originated in the counties of Devon and Somerset in England. It is one of the oldest breeds in England. The cows weigh from 1,300 to 1,500 pounds, while the bulls vary from 1,500 to 2,000 pounds. They are bright red in colour, white only being permissible on the udder or underline, back of the navel. Very few of these cattle are to be found in Canada or the United States.

The Brown Swiss

The Brown Swiss is one of the oldest breeds of cattle known. They had their origin in the valleys and on the mountain sides of Switzerland, and are by far the best known breed of that country.

The Brown Swiss are fairly large, the cows weighing from 1,200 to 1,400 pounds, while the bulls frequently weigh a ton. They are rather heavy of bone and a trifle coarse in make-up. In colour they vary from a silvery grey to almost black and usually have a light-coloured strip down the back. They are very hardy and fairly prolific and are considered fair producers of milk. They are fairly well distributed through parts of Europe and are becoming fairly popular in some parts of the United States, but are not found to any extent in Canada.

The Red Polled

The Red Polled cattle are of ancient English origin. They were developed in the counties of Norfolk and Suffolk in eastern England. They are fairly large, early-maturing animals, the cows weighing from 1,100 to 1,500 pounds, while the bulls vary from 1,700 to 2,000 pounds. The most popular colour is a solid deep red with an occasional white patch on the udder. As their name indicates, the breed is entirely without horns. Red Polled cattle are fairly good milkers and produce a good quality of beef as well. They are hardy and are quite popular in parts of England and Ireland. They have made some headway in the United States and Western Canada but are little known in Ontario.

FEEDING STANDARDS

While feeding standards are not an absolute guide in feeding, yet they give the farmer some idea of the amount of feed necessary for economic and efficient feeding. Scientists, as well as practical feeders, have spent considerable time during the past fifty years in trying to work out standards that would absolutely fill the needs. Probably none of these standards can be termed perfect, but the modified Wolf-Lehman standard which is published below will give the reader some idea of the amount of dry matter, digestible protein, and digestible carbohydrates and fat. It does not mention the amount of mineral matter necessary as this is a comparatively new phase in the study of feeds.

It must be borne in mind in making up rations from these standards that the individuality of the animal must be taken into consideration as well as the absolute necessity of giving the high producing dairy cow considerable variety of feed to add to its palatability.

TABLE I

MODIFIED WOLF-LEHMAN STANDARD

	Dry Matter	Digestible Protein	Dig. Carbohydrates and Fat x 2¼
1,000-pound cow giving 3.5% milk:	Lbs.	Lbs.	Lbs.
Cow dry	14.0	.70	7.22
Cow giving 10 pounds milk	16.5	1.25	9.83
" " 15 " "	19.0	1.55	11.13
" " 20 " "	21.5	1.83	12.44
" " 25 " "	24.0	2.12	13.75
" " 30 " "	26.0	2.39	15.05
" " 35 " "	28.0	2.67	16.36
" " 40 " "	30.0	2.95	17.66
1,000-pound cow giving 4% milk:			
Cow dry	14.0	.70	7.23
Cow giving 10 pounds milk	16.5	1.30	10.09
" " 15 " "	19.0	1.60	11.52
" " 20 " "	21.5	1.94	12.91
" " 25 " "	24.0	2.28	14.30
" " 30 " "	26.5	2.59	15.72
" " 35 " "	29.0	2.91	17.13
" " 40 " "	31.0	3.16	18.60
1,000-pound cow giving 4.5% milk:			
Cow dry	14.0	.70	7.23
Cow giving 10 pounds milk	17.0	1.33	10.36
" " 15 " "	19.5	1.65	11.92
" " 20 " "	22.0	2.00	13.45
" " 25 " "	25.0	2.36	15.00
" " 30 " "	27.5	2.66	16.55
" " 35 " "	30.0	2.99	18.10
For each 100 pound increase in weight of cow add	1.4	.07	.72

FORMULATING RATIONS

In using these tables for computing rations the following suggestions may be useful:

(1) That a deficiency of two or three pounds of dry matter in a ration where over 20 pounds is recommended, is not a serious mistake provided the feeder knows that the whole ration is bulky enough to satisfy the craving of the cow for a full stomach. This lack of dry matter in the ration will often occur where a high grade roughage like alfalfa hay or good silage is being fed, in which case the proper amount of digestible protein or carbohydrates is reached before the quantity of dry matter is high enough.

(2) As a basis of computing a trial ration it is well known that a cow should have approximately one pound of dry roughage (hay, straw, etc.) and three pounds silage (or four to five pounds silage and roots) for each hundred pounds of live weight. If no silage or roots are available, she should have two pounds dry roughage for each one hundred pounds of live weight.

(3) To bring the ration up to the standard, the concentrates or grain fed should be fed at the rate of about one pound of grain for each three to five pounds milk produced, depending on the quality of the milk—the richer the milk the more grain.

Keeping in mind the above recommendations, we shall proceed to formulate a ration. We shall suppose that the feeder has at hand, at a reasonable price, the following feeds: Corn silage, clover hay, oat straw, bran, oats, and oil meal. He wishes to feed a standard ration to a 1,100-pound cow giving twenty-five pounds of four per cent. milk per day. According to our standard in Table I, the requirements are:—

	Dry Matter	Protein	Carbohydrates and Fat
	Lbs.	Lbs.	Lbs.
	24.0	2.28	14.30
Add for 100 pounds extra weight of cow.....	1.4	.07	.72
	25.4	2.35	15.00

Turning to the table of digestible nutrients of the different feeds on Table IV, we find the feeds of this ration to be composed as follows:—

TABLE II

In 100 pounds of	Dry matter	Digestible protein	Digestible carbohydrates and fat x 2¼
	Lbs.	Lbs.	Lbs.
Bran.....	89.9	12.5	48.4
Oats.....	90.8	9.7	60.7
Oil meal.....	90.9	30.2	47.7
Silage.....	26.3	1.1	16.6
Clover hay.....	87.1	7.6	43.4
Oat straw.....	88.5	1.0	44.6

First Trial Ration for 1,100 Pound Cow Giving 25 Pounds 4 Per Cent. Milk per Day

Feed	Dry matter	Digestible protein	Dig. fat and carbohydrates	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Silage.....35 pounds	9.21	.39	5.81	
Clover hay..... 7 "	6.10	.53	3.04	
Oat straw..... 4 "	3.54	.04	1.78	
Bran..... 3 "	2.70	.38	1.45	
Oats..... 2 "	1.82	.19	1.21	
	23.37	1.53	13.29	1:8.8
Standard.....	25.40	2.35	15.00	1:6.3
Additional requirements.....	2.03	.82	1.71	

The dry matter in this trial ration is nearly up to the standard, but the protein is more than 25 per cent. too low, while the digestible carbohydrates and fat are about 10 per cent. too low. To more nearly balance this ration it is therefore necessary to add a protein-rich feed, and, to keep the dry matter and the amount of grain within reasonable bounds, it is necessary to use more protein-rich roughage like clover hay instead of so much poor roughage as oat straw.

TABLE III
SECOND TRIAL RATION

Feed	Dry matter	Digestible protein	Dig. fat and carbohydrates	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Silage.....35 pounds	9.21	.39	5.81	
Clover hay.....12 "	10.45	.91	5.21	
Bran..... 3 "	2.70	.38	1.45	
Oats..... 3 "	2.72	.28	1.82	
Oil meal..... 1½ "	1.36	.45	.72	
	26.44	2.41	15.01	1:6.2
Standard.....	25.40	2.35	15.00	1:6.3
Difference.....	1.04	.06	.01	

This ration approximates the standard so closely that it may be considered well-balanced, but since all the nutrients are a trifle high, experience would suggest that about a pound of the grain mixture be taken away and that for a couple of pounds of clover hay there be substituted as much straw as the animal would eat.

FOOD REQUIREMENTS

In order to understand something of the requirement for milk-production it is well to study the amount of the different ingredients found in the milk. Milk contains: Water, 87.2%; mineral, .7%; protein, 3.5%; sugar, 4.9%; fat, 3.7%. A good average cow should give at least 8,000 pounds of milk in a year, and by so doing would yield 272 pounds of protein, 296 pounds fat, 392 pounds milk-sugar, and 56 pounds of mineral matter. The carcass of a two-year-old steer finished for market and weighing 1,200 pounds, would contain 192 pounds of protein, 44.4 pounds mineral matter, 387.6 pounds fat. Thus the cow yields more protein and mineral matter each year than has been built up in the steer's body during its entire life. Besides this, she is storing considerable protein and mineral matter in developing the unborn calf.

In order to yield the large amount of nutrients mentioned above, it is evident that the dairy cow requires a large amount of feed, particularly feed rich in protein and mineral matter. At the same time, large amounts of other nutrients are necessary for carrying on digestion, assimilation and other processes which go on in the animal body. About half of a liberal ration fed to a dairy cow is used for body maintenance while the other half is used for milk production. If deficient rations are fed the milk supply will go down, consequently the inability of some farmers to get a good flow of milk is due to poor feeding.

Legume hay is one of the best feeds for dairy cattle. Not only is it rich in protein but contains large quantities of mineral substances in available form, and also contains the vitamines necessary in the animal body.

The value of a feed is largely determined by its composition, digestibility and palatability. By its composition is meant the amounts of different ingredients which are necessary in the animal body. These are proteids, carbohydrates, fat and mineral matter. The proteids contain nitrogen and are used for the formation of muscle, hide, hair and general growth. They also are used in large quantities for milk-production. No other ingredient can take their place. Protein is found in greatest quantities in such feeds as clover and alfalfa hay, cottonseed meal, oil cake, gluten feed, and bran. The carbohydrates, which are the starches and sugars, and the fat, supply the heat and energy in the animal body and are also the source of fat that is stored up in the animal body and the

fat in the milk. While the fat and carbohydrates perform the same function in the body, one pound of fat is equal to two and one-quarter pounds of carbohydrates for the production of heat and energy.

The ash or mineral matter is used to form bone and to assist in the secretion of the fluids and juices of the digestive tract as well as milk.

The digestibility of feeds plays an important part in their value to the animal. Generally speaking, the more fibre or woody matter in the feed, the harder it is to digest. Feeds of a succulent nature assist the animal in digesting the dry feeds which contain large quantities of fibre. The following table will give some dea of the amount of digestible nutrients in some of our common foodstuffs:—

TABLE IV

AVERAGE DIGESTIBLE NUTRIENTS IN 100 POUNDS OF FEEDING STUFFS

Name of feeds	Total dry matter	Digestible protein	Digestible carbohydrates fat x 2¼	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Corn	89.4	7.8	76.5	1-9.8
Corn-and-cob meal	89.6	6.1	71.5	1-11.7
Wheat	89.5	8.8	70.8	1-8.0
Barley	89.2	8.4	68.9	1-8.2
Oats	90.8	9.7	60.7	1-6.7
Peas	85.0	19.7	50.2	1-2.54
Beans	87.2	18.3	56.1	1-3.1
Buckwheat	86.6	8.1	53.6	1-6.6
Gluten meal	90.5	29.7	56.2	1-1.9
Gluten feed	90.8	21.3	59.3	1-2.78
Linseed meal, old process	90.9	30.2	47.7	1-1.57
Cottonseed meal	93.0	37.6	43.0	1-1.14
Dried brewers' grains	91.3	20.0	45.7	1-2.28
Wet brewers' grains	23.0	4.9	13.22	1-2.7
Dried distillers' grains	92.4	22.8	65.8	1-2.88
Malt sprouts	90.5	20.3	49.1	1-2.4
Buckwheat middlings	87.2	22.7	51.22	1-2.25
Wheat middlings	88.8	13.0	55.82	1-4.29
Bran	89.9	12.5	48.4	1-4.0
Clover hay	87.1	7.6	43.4	1-5.9
Timothy hay	86.8	2.8	45.3	1-16.2
Alfalfa hay	91.9	10.5	42.52	1- 4.05
Millet hay	86.0	5.2	40.4	1- 7.7
Clover (green)	29.2	2.9	15.16	1- 5.23
Timothy (green)	38.4	1.5	21.25	1-14.1
Alfalfa (green)	28.2	3.6	13.0	1- 3.6
Millet (green)	25.0	1.6	15.07	1- 9.4
Oat straw	88.5	1.0	44.6	1-31.8
Rye straw	92.9	0.7	40.5	1-58.0
Wheat straw	90.4	0.8	36.1	1-45.0
Barley straw	85.8	0.9	41.45	1-46.0
Oat hay	86.0	4.7	40.5	1- 8.62
Oat forage (green)	25.0	2.6	12.35	1- 4.75
Blue grass (Kentucky)	34.9	2.8	21.5	1- 7.7
Pasture grass	20.0	2.5	11.2	1- 4.5
Corn stover	59.5	1.4	32.77	1-23.4
Corn fodder	81.7	3.0	50.67	1-16.7
Corn silage (well matured)	26.3	1.1	16.6	1-15.0
Corn silage (immature)	21.0	1.0	12.3	1-12.3
Turnips	9.5	1.0	64.5	1- 6.4
Mangels	9.4	0.8	6.62	1- 8.2
Sorgum (green)	24.9	0.7	15.4	1-22.1
Whole milk	13.6	3.3	14.57	1- 4.4
Skim milk	9.9	3.6	5.55	1- 1.5
Buttermilk	9.4	3.4	5.12	1- 1.5
Whey	6.6	0.8	5.37	1- 6.8
Beet pulp (dry)	91.8	4.6	67.0	1-14.6
Beet pulp (wet)	9.3	0.5	6.9	1-13.8

From "Feeds and Feeding," by Henry and Morrison.

Closely related to the digestibility of a feed is its palatability. Animals differ somewhat in the amounts of different feeds they can digest, depending largely on their likes and dislikes. The feeder should always aim to provide a feed which caters to the likes of the animal. Variety of feeds rather than too much of one feed will also add to palatability and consequently will give better results.

Characteristics of Feeds

Oats.—Oats are the most extensively-grown cereal in Ontario. For dairy cows as well as for growing stock, there is no better feed to be found on the farm. They contain a larger amount of protein than any other grain grown on the farm except Canadian peas. When ground, they are bulky in nature which makes them very desirable for the dairy cow. They are very palatable and are relished by all classes of stock. For young and growing animals, no other grain is as well suited. They may be fed whole to calves up till six or seven months of age; after that they are better crushed. Besides being a valuable feed for growth and milk-production, they are also useful to mix with other feeds and thus add bulk to the ration. Oats are very nearly a perfect concentrate ration for young cattle. And no other grain, if fed singly, comes as close to a perfect ration for milch cows. They are, however, often too high in price to be fed in this manner.

Barley.—Barley is a very valuable feed on the farm, particularly for fattening purposes. It may be fed to dairy cattle if mixed with oats or wheat bran. Barley is not quite so high in protein as oats but contains a higher percentage of easily-digestible carbohydrates. It is, however, of a heavy nature when ground and should be made lighter by mixing with such feeds as oats and bran. It may safely be fed to dairy cows up to half the grain ration but on account of its heating qualities should never be fed just before or after freshening.

Wheat.—Owing to its high price wheat is not usually fed to dairy cows. It is, however, a rich feed in protein, carbohydrates and fat. It is necessary when fed to dairy cattle to supplement it with some protein-rich feed. It is also heavy in nature and will give best results when mixed with bran or oats. Poor-quality wheat is often fed and is about the same value, pound for pound, as barley. Elevator screenings often contain considerable wheat and their value as a stock feed is largely determined by the percentage of wheat in them.

Corn.—Although rather low in protein, corn is rich in digestible carbohydrates and fat. It is extremely palatable, is easily masticated and readily assimilated but should never form more than half the ration of a dairy cow. It should always be ground and fed along with other concentrates rich in protein and light in character such as oats or bran. Corn-and-cob meal is better for dairy feeding than pure cornmeal, as it is more bulky and thus better suited to the needs of a dairy cow.

On account of its high percentage of easily-digestible carbohydrates and fat, corn is a valuable supplement for feeding with skim-milk to calves.

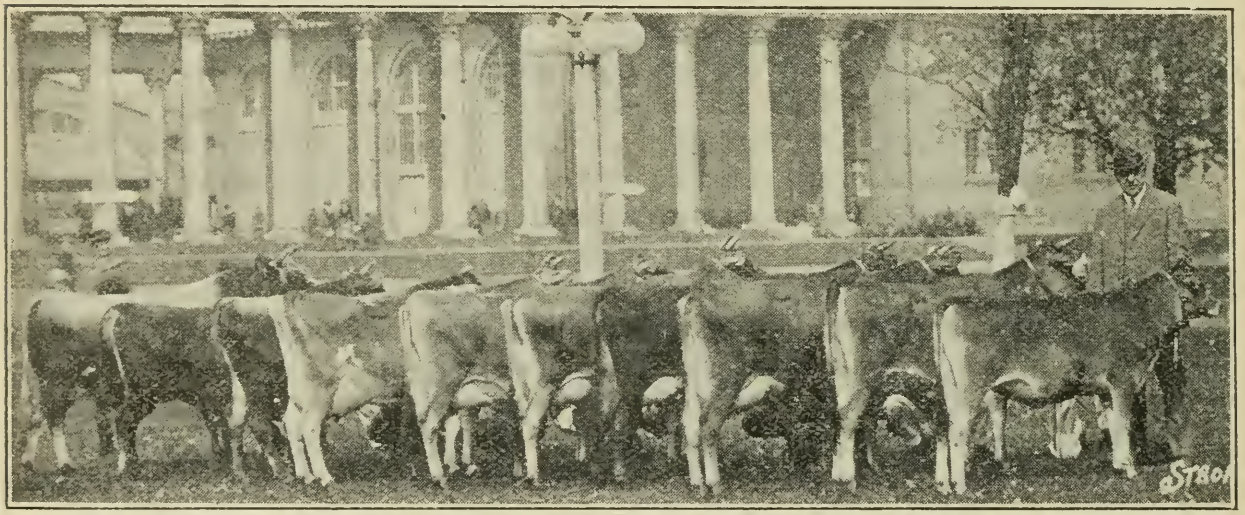
Peas.—Peas contain a very high percentage of protein and are rich in fat, carbohydrates and mineral matter. They are palatable and easily digestible. On account of their heavy nature, when ground, it is necessary to mix with lighter feeds, such as oats or bran, to get best results. The price of this grain makes it impracticable as a general feed for milk-production, but peas are often used to feed to test-cows when high records are wanted.

Rye.—Rye is not much used for cattle feed in Ontario. It is not palatable and tends to produce a hard, dry butter. Neither has it the feeding value of other grains. If available at low prices, it could be fed in small quantities mixed with other grains.

Buckwheat.—Buckwheat is sometimes used for dairy cattle in Ontario. It has a fair feeding value and if cheap could be used to take the place of corn or barley in a ration. It should not be fed in large quantities as it is rather sticky in nature and is not palatable if it constitutes too high a percentage of the ration.

By-Products—Concentrates

Bran.—Bran as a concentrate feed for dairy cattle is the best known and most widely used of all by-products. In addition to supplying in large quantities the two most important feed ingredients for dairy cattle, viz., protein and ash, it has other properties as well. It has a mild laxative action on the digestive system and hence may be used for animals that are sick or just before or after calving. It is light in character and may be fed in any amount with safety. It is also useful to mix with heavier grains to lighten up the ration. It is also very palat-



Ontario Jersey Herd.
First prize State Herd at the National Dairy Show, Syracuse, 1923.

able. Bran is nearly equal to oats in feeding value, and is particularly useful for heavy-milking cows and growing animals. Although comparatively high in price, bran will continue to hold first place as the most important by-product concentrate for dairy cattle.

Shorts or Middlings.—Although a little richer than bran in most of the nutrients, shorts are heavier and more sticky in texture, which detracts considerably from their value as a feed for dairy cattle. When obtainable at about the same price as bran, they will yield good returns as part of the meal ration. They should be mixed with bran or oats as they are rather heavy in nature. Good shorts are fine and flour-like in texture and lighter-coloured than bran. There is, however, quite a variation in these products but as a rule they are a little heavy and too sticky in nature for feed for dairy cattle.

Dried Brewers' Grains.—This is the residue from barley after the removal of the soluble sugars and starch for the manufacture of malt liquors. They are rich in protein but have very little carbohydrates. According to experiments at the Ontario Agricultural College, they are worth slightly more than bran, pound for pound, for milk-production. On account of their large fibre content they should be mixed to get best results. They are quite palatable and, owing to their bulky nature, are valuable to lighten up a heavy meal ration.

They are sometimes sold in the wet condition, but as such can only be used in districts close to the breweries as it is impossible to store them.

Cottonseed Meal.—Cottonseed meal is the richest of all dairy-stock feeds in protein. Thus it is the cheapest source of protein known and one of the best feeds for milk-production. It is, however, useful for one specific purpose and that is to increase the protein content of the ration for dairy cows. Cottonseed meal is very constipating in nature and consequently should not be fed unless mixed with other meals which will counteract this action or with succulent roughage in the ration. It should only be fed in small quantities at any time and should be avoided at freshening time. As a feed for young stock it is not as valuable as some other feeds such as bran or oil cake.

Gluten Feed.—Gluten feed contains about twice as much protein as bran. In addition, it furnishes considerable more total digestible nutrients. It is quite palatable when fed in a suitable concentrate mixture to dairy cows. It is slightly higher in total nutrients than oil cake or cottonseed meal but contains only about two-thirds as much digestible crude protein. So when it is fed to increase the protein content of a feed mixture, more pounds are needed than of either oil cake or cottonseed.

Gluten meal is very seldom found on the market at the present time as most of it is combined with the corn bran to form gluten feed which is the standard by-product of starch factories.

Linseed Meal or Oil Cake.—The old process linseed meal is one of the most valuable feeds for dairy cattle. Not only does this by-product of flaxseed contain large quantities of crude protein but it has a laxative and conditioning effect on the animal body. It is the most valuable feed when no succulent feed is available or when hay from grasses or corn silage must be fed in place of legume hay. It is highly palatable to cattle and is greatly esteemed by feeders when fitting for show or sale. It is also used extensively for test-cows and is useful in the cow's ration at freshening time. Although not as cheap a source of protein as cottonseed, yet owing to its other beneficial qualities it is more generally used.

Molasses Feeds.—These consist of various products, some of which are good while others are poor, such as oat hulls, mill screenings, etc., combined with molasses. Many of them contain foul-weed seeds and most of them are sold at prices beyond their value. Some of the best grades have a beneficial effect but the same could be obtained more cheaply by feeding feed molasses. The best advice to the average farmer is to leave them entirely alone.

Roughages

Alfalfa.—Alfalfa is one of the best roughage feeds known. It does not stand pasturing well but makes splendid hay. It is richer in protein than red clover but contains less fat and carbohydrates. Alfalfa, if cut just when the new shoots are starting at the base of the old plants, yields the maximum amount of hay with a large percentage of leaf. By feeding good alfalfa hay, the dairyman is able to reduce his meal ration considerably. It makes an excellent feed for young and growing stock as well as for milch cows. It also makes a valuable feed for soiling purposes as it grows rapidly in the spring and springs up quickly after cutting. It is also very palatable after the stock become accustomed to it.

Red Clover.—Red clover is another of the best roughages for all classes of stock. It makes excellent hay as well as a good soiling crop. It does not yield

as much per acre as alfalfa. While used extensively for pasture in this country, it does not yield as much as some other crops. It works into the general rotation better than alfalfa and is more generally grown and consequently is one of our most important roughages. It should be cut soon after full bloom to get the best quality of hay. It also makes a good soiling crop.

Alsike.—Alsike clover is about the same in composition as red clover but is not so generally grown for hay in this country. It is not as palatable and is not as well liked by dairy cattle. It does well on damp soil where red clover will not grow. If threshed, both alsike and red-clover straw have slightly higher value than the cereal straws.

Sweet Clover.—There has been considerable discussion during the past few years about the value of sweet clover as a feed for dairy cattle. It is a coarser feed than the other clovers and is somewhat harder to cure for hay. After several years' experience on the College farm with sweet clover, it would seem that its chief value is as a pasture crop, a soil-builder, and in some cases as silage. As a pasture, it gives excellent results. It should be sown thickly as thin-sowing causes very coarse plants. Dairy cattle will do best if given the run of another pasture as well. The value as a soil-builder is already well known, being equal to that of other clover crops.

As a silage crop, its main value is in districts where corn cannot be grown. It can be grown more cheaply than corn but will not yield as heavily. It is a little more difficult to ensile than corn and greater care is necessary to get good silage. It should be handled promptly and not allowed to dry out. It should be cut in the late bud stage, put in the silo immediately and well packed.

During the winter of 1923, a feeding test with sweet-clover silage was made at the Ontario Agricultural College. Seven dairy cows at about the same lactation were selected and the sweet-clover silage was fed against corn silage. The silage was in excellent condition and was free from mould. The results showed that, pound for pound, the sweet-clover silage gave a little the better results, yielding 81.5 pounds more milk in the three weeks. The cows also gained in weight during the sweet-clover feeding and lost slightly on the corn. However, this was not the case when the cows got all the corn silage they would eat.

TABLE SHOWING QUANTITY OF SILAGE EATEN PER DAY

Cow No.	Check period on corn silage	Test period on sweet clover silage	Test period on corn silage
	Lbs.	Lbs.	Lbs.
1	36.0	23.1	23.1
2	34.3	23.8	23.8
3	34.5	23.3	23.3
4	34.7	21.2	21.2
5	38.0	23.8	23.8
6	35.7	21.9	21.9
7	37.5	23.0	23.0

Before starting the experiment, as seen by the table, the cows were eating about 35 pounds of corn silage each. When put on sweet-clover silage, the most any of them would eat was 23 pounds. The following table shows the analyses of the two silages:—

	Sweet-clover silage	Corn silage
	%	%
Moisture	76.66	70.92
Protein	4.00	2.40
Fat	1.99	.83
Fibre	7.94	7.17
Ash	1.59	1.39
Carbohydrates	7.82	17.29

The following table is a summary of the experiment:—

SWEET CLOVER vs. CORN SILAGE—FEEDS AND YIELDS FOR A THREE WEEKS' PERIOD

No. of Cow	Grain	Mangels	Hay	Silage fed	Sweet clover		Corn silage	
					Gain or loss in weight	Total milk yield	Gain or loss in weight	Total milk yield
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	307	764	210	486	+44	733.9	−10	750.2
2	168	630	210	500	+30	485.6	+ 4	475.2
3	231	658	210	490	+ 9	551.9	− 9	546.0
4	274	760	210	446	+25	678.0	−41	677.0
5	304	840	210	500	−13	901.9	−26	866.1
6	256	735	207	458	− 3	501.8	+26	492.6
7	286	840	204	484	+17	574.6	+28	539.3
Totals	1,826	5,197	1,461	3,364	+109	4,427.7	−28	4,346.4

Pea and Oat Hay.—When clover kills out and a substitute is needed to provide the necessary hay for winter, a mixture of peas and oats is about the best that can be grown. This hay is rich in protein and is quite palatable. It also yields well. It should be cut when the peas are in full bloom and the oats in the milk stage.

Timothy.—While timothy hay is the standard and most satisfactory roughage for horses, it is not as satisfactory for dairy cattle. It is lower in protein than clover hay and is usually not as palatable. It contains a large proportion of digestible carbohydrates. If fed to dairy cattle it is best to cut when quite young. It is necessary to feed cows more concentrates than if fed on hay from legumes. A mixture of red clover and timothy is often fed, and where the mixture contains considerable clover, it is a very satisfactory feed for dairy cattle.

Blue Grass.—This is very seldom used for hay but is one of the best pasture crops known. As a hay, it does not yield very well but makes an excellent feed if properly cured. It is inferior to good clover hay but is better than timothy for dairy cattle.

Orchard Grass.—Orchard grass is grown to a slight extent in Ontario. It is coarser and less palatable and, as a hay crop, it is harder to cure than timothy. As a pasture crop, it withstands the hot weather well and will do well in the shade but is not relished so well by the stock. It is excellent to mix with other grasses and clover in a permanent pasture mixture.

Straw.—All classes of straw are very high in fibre and consequently of little use as a feed for dairy cows. If fed as a roughage, considerably more concentrates are necessary to properly balance the ration. For dry cows it may be used as part of the roughage. Taking everything into consideration, oat straw is about the best. Barley straw about equals oat straw in feeding value while wheat and rye straw have a little lower feeding value. Buckwheat straw contains a little more protein but is so high in fibre that it is unsatisfactory as a feed. The straw from legumes has a little higher feeding value than that from the cereals.

Millet.—Millet is usually grown as a catch crop in this country. It is usually fed as hay but may be used for soiling purposes. Where it is sown thickly and cut before it becomes too ripe it will make a little better hay for dairy cattle than timothy.

Corn Fodder.—By corn fodder is meant the corn plant with the ear attached. It is a valuable roughage on account of the amount that can be grown per acre. It is low in protein but fairly rich in carbohydrates. Cut green in the late summer and early fall, it is valuable for silage purposes. When dried it is a valuable feed for fall and early winter, being about equal to timothy for milk-production. Later than this it becomes dry and woody which causes considerable waste. It should be run through the cutting box to get best results. Corn for this purpose should be sown very thickly so as to get a higher percentage of leaf and so the stocks are not too thick.

Corn Stover.—Corn stover consists of the cornstalks after the corn has been removed. Thus the crop is more matured than in the case of corn fodder, which detracts from its feeding value. It is of more value than straw but should be run through the cutting box to get best results.

Succulent Feeds

Corn Silage—Corn silage is one of the best roughages for dairy cattle. There is much less waste than if the corn is handled in any other way, and, instead of a dry forage, the silage supplies a large bulk of succulent feed which is particularly valuable during the winter. Not only does it supply the necessary bulk in the ration, but it keeps the animal's system in tone and acts as an appetizer as well. It is also useful for feeding in the summer months as well, when the pasture becomes scarce. Its value as a feed is so well known in Ontario that very little need be said about it here. It is, however, necessary to feed something else along with it as it does not contain sufficient protein for dairy cattle. It should be put in the silo in the glazed stage.

Roots.—Roots are of value as a feed for dairy cattle as they are very palatable and add considerable succulency to the ration. They contain a very high percentage of water and very little dry matter. The dry matter, however, is very digestible. They are also useful in increasing the palatability and digestibility of a ration. For all ages of dairy cattle roots are excellent feed, particularly for young calves just commencing to eat and for test-cows where high milk records are desirable. For some other classes of stock they are probably a little too dear to feed with labour at the present price. Corn silage has replaced roots very largely, as it furnishes the succulent feed necessary for winter feeding a little more cheaply than the roots. A few roots fed with the silage improves a ration considerably.

Mangels and sugar beets are the most valuable for the dairy farm as turnips taint the milk. Mangels will also yield more tonnage per acre than turnips.

Potatoes.—When potatoes are cheap they are sometimes fed to live stock. As a feed for dairy cattle they should only be fed in very small quantities as they are likely to injure the flavour of the milk and texture of the butter.

Dried Beet Pulp.—Dried beet pulp, a by-product of sugar refineries, is often fed as a substitute for silage or roots. It should be moistened with three times its weight of water before feeding and mixed with some molasses to take the place of the sugar taken out of the beets and to add to its palatability. It is bulky in nature and has a laxative effect on the animal. It is low in protein and should be fed with a protein ration.

During the winters of 1922 and 1923, at the Ontario Agricultural College, a feeding test was made with dried beet pulp against mangels for dairy cattle. The milk yield was about the same but the cost of the beet pulp was a little higher. Judging from the results, when mangels are fifteen cents per bushel, beet pulp is worth $20 per ton.

ONTARIO HOLSTEIN HERD.

First prize State Herd at the National Dairy Show, Syracuse, 1923.
The bull, Count Rauwerd Rattler 36584, at the head of the herd owned by Kemptville Agricultural School and bred by the Ontario Agricultural College.

SUMMER MANAGEMENT OF THE MILKING HERD

Dairying in Ontario naturally divides into two distinct practices,—the pasturing of the cattle in summer and stable-feeding in winter. As a rule, the milking herd can live outside for five months but requires some kind of shelter and feeding during the remaining seven. Every dairy farmer knows that in the late spring and early summer the dairy herd usually reaches its maximum production for the year. This is due to the abundance of suitable feed, moderate temperature, comfortable surroundings, and reasonable exercise. These are some of the conditions the farmer must attempt to secure throughout the year in order to get the best results from his herd.

The general practice in this country is to pasture during the summer months. Attempts have been made to feed cattle in the stable during the summer, but this practice is not general throughout the province. The results of an experiment at the Ontario Agricultural College will give the reason why this practice has not become more popular. Fifteen high-producing cows were fed in the stable during June, July, August, and September, under the same conditions as obtained in winter. During the same months, thirty-two cows of only average ability were pastured, with some grain in addition. In the case of the stabled

cows, the feed was charged at slightly less than the market price for that grown on the farm and actual market price for that purchased. In the case of the pastured cows, the actual cost of pasture, which included rent of land, seed, temporary fencing, and labour of man, horse and machinery in seeding pasture, which was partly spring-sown annual pasture, was charged. It is worthy of note that both groups of cows averaged the same number of days from freshening time to the beginning of the test, and the same percentage of cows in each group calved during the test, so that the factor of length of lactation periods was eliminated. The returns from each group are seen in the following table:—

Group	Pounds milk in 4 months.	Daily average per cow	Pounds fat in 4 months	Daily average per cow	Value of grain	Value of roughage	Value of pasture	Total cost of feed	Cost of 100 pounds milk	Cost of 1 pound fat
15 cows stabled.....	56,296	30.8	2,193	1.2	$187.85	$298.36	.....	$486.21	$0.86	$0.22
32 cows pastured....	81,650	20.9	3,372	0.86	178.11	.....	$190.17	368.28	.45	.11

It is therefore quite apparent that from the standpoint of feed costs alone it is more economical to pasture cows in summer than to feed in the stable. If labour had also been taken into account, the results would have been much more marked in favour of the pastured cows.

There seems very little difficulty in getting good pasture in the months of June and early in July, but the latter part of July and the forepart of the month of August is the hardest time of the year to procure suitable pasture. The weather is usually hot and dry and the pasture during this period is usually very scanty. Starting with the middle of August or September, the cattle get the run of more of the farm and the difficulty of getting sufficient pasture is over, except in cases when we have a very dry fall.

Attempts have been made to get pasture crops which will give good results during July and August. The natural pasture, which is largely blue grass, is dried up. Even good clover and timothy pastures do the same. So the large milk-flow of June drops off quickly and seriously affects the yearly production if some other feed is not secured. This difficulty can be overcome in one of three ways,—summer feeding of silage, the feeding of soilage crops, or procuring pasture crops that will overcome the hot, dry weather. The first method is quite feasible, but the soilage-crop method requires considerable more labour than the farmer can profitably spend at that time of the year. The soilage, however, may be used for short periods. Possibly one of the best soilage crops is alfalfa. Another crop that has given good satisfaction is a mixture of peas and oats, three bushels of oats and one-half bushel of peas per acre. The betterment of the pasture crop, however, seems the most useful advice at present. The requirements of a pasture crop for the dry weather are a thick, quick-growing mat and one which will spring up quickly after being eaten off. One of the pastures tried out on the College farm, which gives good results, is an annual pasture composed of three bushels of oats, seven pounds of red clover, four pounds of alfalfa to the acre. This mixture is sown about the middle of May and the cattle turned in when the crop is about six or seven inches high. On being eaten off, the crop immediately commences a rapid and thicker growth and, if not allowed to head out, the growth will continue late into August.

In 1915, seventy-five head of cattle, all over one year of age, were maintained on twenty acres of annual pasture, eight acres of old natural pasture, and thirty acres of third-year sod, sixty-six acres in all, from first turning out in May until August 20th.

Sweet clover has also given good results at the College for this purpose. In 1921, forty-four head of dairy cattle and eight brood sows were turned out on twenty acres, on June 5th, and were left there until August 15th. During that period there was plenty of feed and the stock did well on it.

A satisfactory permanent pasture for land, which does not work into the regular rotation on the farm, is composed of:

4	pounds	red clover.
2	"	alsike.
2	"	alfalfa or white clover.
2	"	orchard grass.
2	"	tall oat grass.
2	"	meadow foxtail.
2	"	Kentucky blue grass.
3	"	timothy.

The above amount will seed an acre. A good combination of pasturage for a dairy farm would be two-thirds of an acre of permanent pasture, two-thirds of an acre of annual pasture for each head over one year of age and the aftermath of the meadows that have been cut for hay.

Grain-Feeding on Pasture

During the change from stable to pasture it is advisable to feed a small amount of grain and probably a small amount of silage as well. It is never well to make a very abrupt change in the cow's ration. After the cows have become accustomed to the change, it is probably not economical to feed any grain while there is an abundance of pasture. A small amount of grain, however, may help to keep the animals in condition that they may withstand the shortage later on. During the heat of the summer, when the flies are bad and the pasture short, the feeding of grain will help to keep up the milk-flow and also keep the animal in good condition. For this purpose a mixture of oats, barley, bran, oilcake and cottonseed proves very satisfactory. From one to two pounds of a mixture per day is sufficient when the pasture is good, with a maximum of five pounds in the hottest weather. If the milk fails with this amount, it can be kept up more economically by soiling crops, silage or better pasture than by increased grain-feeding.

Water, Salt, and Shade

A plentiful supply of clean, fresh water is an absolute necessity in getting good results from the herd in summer. Where it is not possible to have water before them all the time they should be watered at least twice a day, and, in the hot weather, three times. They will also require a good supply of salt while on pasture. Probably the best method is to keep a supply before them at all times so they can help themselves at will. Shade is also necessary in this climate, where the cow can lie down, chew her cud and be protected from the hot rays of the sun. Pasture should be arranged, if possible, where the cow has access to these three important factors—water, salt, and shade.

WINTER MANAGEMENT

As the weather becomes cold in the fall, the cattle should be changed gradually to winter conditions. They should be stabled on cold nights and on cold and wet days, but allowed to run out in the field on fine days as long as possible. The stable should be kept dry and warm and well ventilated. Liberal feeding should be practised during the change. Twice-a-day feeding is usually sufficient, as the cow needs plenty of time to lie down and chew her cud. Where the cows are being tested and are milked oftener than twice a day, three or more feeds should be given. Regularity of feeding is essential as well as regularity of milking and tending. Cleaning and grooming add considerable to the comfort of the cow and should be practised daily. While it is not good practice to allow the cow to run out in all kinds of weather, yet, for the general health of the herd, she should be out for exercise every day except when the weather is very severe. The exception to this would be the cows being pushed for high records, cows nearing calving time, and fresh cows.

The best roughage feeds grown on the farm for a dairy cow are clover or alfalfa hay, corn silage and mangels. A combination of these makes the roughages necessary for an ideal ration. The best concentrates are oats, bran, gluten feed, oilcake and cottonseed. Barley and corn may be used as part of the ration. A good basis on which to make a ration for a dairy cow is in the neighbourhood of one pound of dry roughage for every 100 pounds of animal weight, three pounds of corn silage for every 100 pounds of animal weight, or five pounds mangels or sugar beets for every 100 pounds of animal weight, and a mixture of the concentrates named above fed at the rate of one pound of meal to three to five pounds of milk produced.

The order of feeding depends on the amount of different feeds fed as well as the quality. The silage and roots could be mixed and fed first. It is usually best to feed the grain ration on this feed and follow up with the hay last. The hay is best fed whole unless very dry and of poor quality when it may be cut and mixed with the silage and roots.

THE COW AT CALVING

It is good practice to allow the cow to dry up for at least six weeks before calving time. This will allow her to lay on some fat and also to store up energy for calving time and the next lactation period. It is a well-established fact that the more fat the cow has on her body at calving time, the higher percentage of butter-fat will be in the milk for some time after freshening.

As calving time approaches she should be allowed plenty of exercise in a box-stall in winter or in pasture during the summer. She should receive a liberal supply of roughages with plenty of succulent feed such as roots or silage. A limited supply of grain could be given. This part of the ration should contain oats, bran, oilmeal or gluten feed, but in no case should barley, corn or cottonseed be fed. The attendant should be on hand at calving time. If the cow's udder is hard and inflamed, it is good practice to leave the calf with the cow for a day or two. In any case the calf should get the first milk drawn from the cow. The cow should not be milked dry for the first three or four days. If everything is progressing normally, in three or four days the grain ration may be increased and the usual milking periods commenced. It is well not to get up to the maximum grain ration for ten or twelve days. Such increase should be made very gradually. If the afterbirth is retained it should be removed by a competent person within forty-eight hours after calving. After the afterbirth is removed

it is well to flush with an antiseptic solution for this purpose. Boracic acid is preferable to any of the coal-tar products. If the udder is inflamed or caked, massaging with an application of hot water, followed by rubbing on melted lard or vaseline, will prove helpful.

THE HERD BULL

The entire care of the bull should be with a view to keeping his vigour and reproducing power at their highest point. Not only must he be fed properly, but he should have sufficient exercise to keep him active and vigorous. As a calf, he should be fed for growth. He should get new milk a little longer than is ordinarily fed to heifer calves. The change from whole milk to skim-milk should be made gradually. He should be kept inside in the daytime and allowed

Ontario Ayrshire Herd.
First prize State Herd at the National Dairy Show, Milwaukee, 1924.

to run out at nights during the summer months. In winter he should be allowed out on fine days and should be handled continually. The bull is usually quieter when kept stabled where he can see the cows. He should have a roomy box-stall where he has plenty of space to move around. He should never be teased or fooled with by anyone. A bull over a year old should never be handled without a staff.

Feed for a bull, like that of the cow, should be of a bulky nature, but should not be too coarse or watery, such as a heavy silage ration. This has a tendency to produce too much middle, which makes him slow and clumsy. Clover hay should form the bulk of a bull's ration with an addition of a small amount of roots and silage. A fair rule is one pound of clover hay to every 100 pounds of weight of the bull, one pound of roots to every 100 pounds of weight of the bull, and one pound of silage to every 100 pounds of weight of the bull. The grain feed should be composed largely of oats with a little bran or oilcake. This should be fed at the rate of two to six pounds per day, depending on the size of the bull. For the young and growing bull more liberal feeding may be done, as growth has to be provided for. In the summer, it is a good practice to cut some green feed such as clover, alfalfa or a mixture of oats and peas, while, later in the season, corn will do very well. Dairy bulls never allowed to get too fat, and with sufficient exercise, will remain active for years.

The average cost of feed, at the Ontario Agricultural College, for the three mature dairy bulls was from $70 to $75 per year; this, with the cost of labour added, amounted to $100 per year. If interest on investment and housing were taken into consideration, this would still be higher. The average ration fed for the winter, when these figures were secured, was from three to five pounds of grain, twelve pounds of hay, twenty-three pounds of silage, and twenty-three pounds of roots. For a man keeping a bull for service, at this rate, would require fifty cows at $2 each in order to pay for the feed and labour.

THE CALF

The best and safest way of improving the milking qualities of a herd of cows is to raise the heifer calves from the best cows in the herd. Inferior heifers and the majority of bull calves should be vealed and thus got rid of as early as possible. After birth, the calf should be removed from the sight of the cow within the first three days. Some dairymen recommend taking them away at birth, but the calf will get a better start if allowed to suck for a few days. If the cow's udder is swollen, leaving the calf for a few days will prove beneficial. The calf should be taught to drink, and probably no better method is known than the old-fashioned one of using the finger. Different mechanical contrivances have been tried but have not been found practical due to the difficulty of being kept clean.

The development of the heifer may quite readily be divided into four distinct periods. The milk-feeding period extends from birth until six or eight months of age. From then until she is bred constitutes the second period. The third extends during pregnancy, and the fourth is the first lactation period. Each period requires different feeding and different management.

For the first three weeks the calf should receive whole milk, starting with five or six pounds for the first few days, or possibly more for the large, lusty calf. Feeding should be done twice daily, probably three times a day at the start. Care should be taken to always have the milk at the same temperature, around 100°F. The allowance of milk should be gradually increased, but overfeeding should be avoided. A safe rule is always to keep the calf a little hungry. Probably twelve pounds of milk per day would be sufficient for a large calf at three weeks of age. At three weeks of age, the calf should be gradually changed from whole to skim milk, taking about one to two weeks to make the change. A fat-substitute should be added to take the place of the butter fat which has been removed from the milk. Flaxseed jelly is one of the best substitutes to use. This is made by boiling a pound of flaxseed in a gallon of water until a thick jelly is formed. While the change from whole milk to skim milk is being made, a tablespoonful of jelly should be added to the milk, gradually increasing the amount until at one month old a half-cupful may be fed at each feed.

The Central Experimental Farm recommends the following as a fat-substitute:

One part ground flaxseed;
Two parts fine cornmeal, sifted;
Two parts finely ground oatmeal, sifted.

Boil and allow to stand for twelve hours. Begin with one-eighth pound per day when the calf is one month old, new milk being fed for the month previous. Increase the amount per day as the calf grows older until one-half pound is being fed.

At four to six weeks of age, a little grain should be fed after the milk. At the same time, a little good clover or alfalfa hay could be placed in front of them. At first they will eat about equal quantities of grain and hay, but as the paunch develops the proportion of roughage may be increased. At six months they will take about three times as much hay as grain. The growing heifer should be encouraged to eat a goodly amount of hay in order to develop the roomy digestive tract desired in a dairy cow. A small amount of succulent feed should be fed, starting at about two to three months of age, either silage or roots. Considerable care is necessary, as overfeeding of succulent feed may cause scours. Calves not gaining rapidly enough should be restricted somewhat in succulent feed, leaving more room for concentrates and hay. At six or eight months, the milk may be discontinued and from this on the rearing of the heifer is comparatively easy.

Pasturing of calves under six months of age is not to be advised. The calves will do better if kept in a dry pen or shed, where they can be fed conveniently. This pen should be darkened through the day in hot weather to prevent fly trouble. It is, however, good practice to allow them to run out at night during the hot weather and thus add to their comfort as well as give them a chance to take sufficient exercise.

THE HEIFER

The handling of the heifer during the period of her life, from six to eight months of age until she is bred, is comparatively simple. There are, however, a few essentials that must be kept in mind since the usefulness of the cow when mature is largely dependent on her proper development before the first calf is dropped.

Heifers, on good pasture, will not require any additional feed, but caution is necessary as pastures often become parched or otherwise insufficient, and the heifer is liable to suffer more from neglect in the summertime than in the winter. In winter there is no better ration than legume hay, silage and sufficient concentrates to keep them thrifty and growing without becoming too fat. It is absolutely necessary for the growing heifers to have sufficient protein and mineral matter in order that they develop strong frames and vigorous constitutions. Clover and alfalfa hay are very rich in these ingredients as well as containing the necessary vitamines. A liberal supply of this hay will ensure proper development. Where clover hay is not available an increase in the grain ration will be necessary.

Heifers fed on a liberal ration will mature earlier than if fed on a scanty ration and will make larger cows, hence the reason for small cows in our herds is usually due to a scanty ration when young. Many breeders believe that a heifer if allowed to become too fat will develop a tendency to use much of her feed for the foundation of body fat which will persist when she is in milk. The conclusions of many experiments point to the facts that heifers that become too fat make slightly inferior cows even if they lose their fat after coming in milk. Any effect of such overfeeding while young is of little importance in determining the productiveness of a cow compared with her inherited qualities. But the chief argument against such practice is the increase in cost of growing the heifer as it is necessary to use a larger percentage of high-priced concentrates.

The age of breeding a heifer depends largely on the breed and the size and development of the individual. Jerseys and Guernseys, which have been well fed, should usually be bred at about fifteen or seventeen months of age, while the

slower-maturing breeds, such as Holsteins and Ayrshires, from eighteen to twenty months. It is commonly believed that if the heifer calves at an early age the tendency to milk-production will be intensified, but, judging from the report of available data, the indications are that the highest milk yields are usually secured from cows that are well grown before lactation begins. Gestation has very little effect on the rate of growth of the well-fed heifer, but it is materially checked as soon as lactation begins owing to the large amount of nutrients needed for milk production. Heifers fed scanty rations and bred too early are usually stunted and are usually finer in bone than those not bred until more mature.

From the time the heifer is bred until calving, she should receive considerable attention in order to assure her future success as a dairy cow. Kindly treatment, frequent handling and abundant feed is necessary. The feed should be nutritious and at the same time bulky in nature. Some meal should be added during the last few months. The heifer should come into milk in good flesh and with udder large and full. As parturition approaches, the feeding of the heifer should be plain without stimulating or heating feed. Good, clean legume hay, corn silage and roots should make up the main portion of her ration.

Directly after calving the heifer should be handled similar to the cow after calving. A bran mash should be given, particularly when the heifer is weak or exhausted, and only warm water should be given to drink. For a few days, the ration should be light until danger of milk fever is over. A heifer with her first calf should be fed liberally since she is growing and producing milk at the same time. It is probably wise not to breed the heifer again for some time after calving so she will be free to devote all her energies to the production of milk. This will tend to establish the "milking habit." The milking of a heifer should have particular attention, as the habits of the cow's whole life are largely determined in her first lactation period. Long lactation periods are desirable, consequently the heifer should milk well up to the twelve months during her first lactation in order that this trait be well developed.

If the heifer is uneasy or nervous it is better to spend a little time and use considerable patience at first or you may have a cow that will always give trouble.

Due to the cost of raising and developing the dairy heifer, only the calves from the best cows in the herd should be raised. The cost for raising a heifer to two years of age, at the Ontario Agricultural College, is around $80. It cost twenty-four cents per day for a two-year-old heifer, twenty-one cents per day for a yearling, and sixteen cents per day for a calf during the winter months. The two-year-olds and yearlings received a ration of clover hay and silage and a meal mixture of oats, bran and a little oil cake. The calves were about three months of age when this experiment started and were fed for three months. They received skim milk and whole milk, equal parts at the start, and were gradually reduced to one part of whole milk to nine parts of skim milk. Besides this, silage, clover hay and a grain mixture of oats and bran were fed.

THE VEAL CALF

Dairy-bred steers are not suitable for beef, so it is necessary to veal the inferior bull calves and some of the cull heifers. The cost of raising young stock on the dairy farm is high, which makes it necessary to raise only the best.

It has always been a debatable point among dairymen as to whether it pays to veal calves or not. Where milk is being sold at a good price it would appear that to veal calves by letting them stay on the cow is not profitable. By weaning them and feeding whole milk, the calf does not gain as rapidly.

During the winter of 1925, records were kept on ten calves in the College herd. These calves were representatives of the three dairy breeds kept at the College—Holsteins, Ayrshires and Jerseys. They averaged seventy-one pounds at birth and were fed for about seven weeks. During that time, 7.98 pounds of whole milk were required for a pound gain in weight. We are able to get $2.80 per hundredweight for our milk during the winter months. This is rather a good price but it must be borne in mind that the milk is of very high quality. Taking the price of the milk at $2.80, and valuing the calf at $5 at birth, the following was the profit realized at the different ages:

Profit at the end of three weeks, $1.90 per calf.
Profit at the end of four weeks, $1.30 per calf.
Profit at the end of five weeks, $0.74 per calf.
Loss at the end of six weeks, $0.09 per calf.
Loss at the end of seven weeks, $0.98 per calf.

This would go to show that the sooner the calf is sent to the butcher, after reaching the age of three weeks, when they can legally be sold, the more profit there is to the farmer. This profit may seem low, but the price of the milk was high and the weight of the calves at birth was rather low.

RATIONS

In addition to the cost of the ration, a number of other items must be borne in mind, such as bulk, palatability, variety, succulency, effect on the system and balance of nutrients.

The digestive system of a dairy cow requires a bulky ration. When possible, the bulky feeds should be rich in protein and mineral, as these ingredients can be added in this way more economically than in the concentrates.

Palatability is an aid to digestibility and also induces the cow to sonsume larger quantities, and consequently a large yield of milk may be expected.

Variety is necessary as an aid to digestibility and palatability and also adds the necessary vitamines to the ration. Rations composed of the products of a single plant are not suitable. Some kind of succulent feed is necessary to keep the system in good running order and also adds palatability to the ration.

The ration should always be balanced. That is, the different nutrients, protein, carbohydrates and fat should be present in the right proportion to nourish the animal without excess or waste of any material.

Soaking of feeds is usually not necessary as it does not increase the digestibility, except in the case of sick cows or at freshening time, when a bran mash may be given.

Cutting of dry roughage does not increase digestibility but sometimes aids in getting inferior feed consumed as it can be more readily mixed with other feeds.

Grinding or crushing of grains is helpful as it assists in mastication. Too fine grinding of some grains may injure their palatability. Cooking or steaming is not advisable.

Feed two pounds of dry roughage or one pound roughage and three pounds of silage per 100 pounds of live weight of animal. Feed grain in proportion to the amount of milk or butter fat produced. Feed one pound of grain per day

for each pound of butter fat produced in a week, or feed one pound of grain for each three to five pounds of milk produced; the richer the milk, the more grain necessary.

In figuring out a grain ration, careful consideration should be given to the kind of roughage fed. Roughages fall into three classes: low protein, medium protein, and high protein. The grain ration will depend upon the class of roughage with which it is fed. The following rations will illustrate this:

Group 1—Low Protein Roughage:

Silage, corn fodder, timothy hay or any hay from grasses. The following grain mixtures should be fed at the rate mentioned above.

Oats	100 pounds		Corn or barley	100 pounds
Bran	100 "	or	Oats	100 "
Cottonseed or oilcake	100 "		Bran	200 "
			Cottonseed or oilcake	100 "

Group 2—Medium Protein Roughage:

Silage and alfalfa or clover hay.

Corn or barley	100 pounds		Corn or barley	100 pounds
Oats	100 "		Wheat bran	100 "
Bran	100 "	or	Gluten feed	100 "
Cottonseed or oilcake	50 "		Cottonseed or oilcake	50 "

Group 3—High Protein Roughage:

All alfalfa or clover hay.

Corn or barley	300 pounds		Corn or barley	100 pounds
Oats	200 "	or	Oats	100 "
Bran	100 "		Bran	100 "
Oilcake	75 "			

Rations for Cows in Milk

Ration I:

Alfalfa hay, 1 pound to every 100 pounds of the animal's weight. Corn silage, 2 pounds to every 100 pounds of the animal's weight. Mangels, 2 pounds to every 100 pounds of the animal's weight.

Grain Mixture:	Oats	2 parts	1 pound to every 4 pounds of milk produced.
	Barley	1 part	
	Bran	2 parts	
	Oilcake	½ part	
	Cottonseed	½ "	

Ration II:

Alfalfa hay, 1 pound to every 100 pounds of the animal's weight. Silage, 3 pounds to every 100 pounds of the animal's weight.

Grain Mixture:	Barley	3 parts	1 pound to every 4 pounds of milk produced.
	Bran or oats	3 "	
	Oilcake	½ part	
	Cottonseed	½ "	

Ration III:

Timothy hay, 1 pound to every 100 pounds of the animal's weight. Mangels, 3-5 pounds to every 100 pounds of the animal's weight.

Grain Mixture:	Barley or corn	4 parts	1 pound to every 4 pounds of milk produced.
	Oilcake	2 "	
	Bran	2 "	

Ration IV:

Roughage, same as No. II.

Grain Mixture:	Oats	6 parts	1 pound to every 4 pounds of milk produced.
	Oil meal	1 part	

Ration V:

Roughage, hay from grasses, 2 pounds to every 100 pounds of the animal's weight.

Grain Mixture:	Oats	2 parts	1 pound to every 4 pounds of milk produced.
	Oil meal	1 part	

Rations for Heifers

Heifers six to twelve months:

Ration I:

6 to 10 pounds silage;
2 pounds grain (100 pounds oats; 100 pounds bran; 40 pounds oilcake);
5 pounds alfalfa hay.

Ration II:

10 pounds colver or alfalfa hay;
2 pounds grain.

Heifers twelve to twenty-four months:

Ration I:

12 to 20 pounds silage;
2 to 3 pounds grain;
8 pounds alfalfa hay.

Ration II:

15 pounds colver or alfalfa hay;
2 to 3 pounds grain.

FEEDING TEST-COWS

When high records are to be made, a little extra care in handling the cow is necessary. She should be allowed a somewhat longer dry spell than is usually given. From eight to twelve weeks is usually sufficient. During the first three or four weeks of the dry period, the cow is allowed to rest and no concentrates are fed. Some breeders differentiate between soft- and hard-fitting. By soft-fitting, the fat is put on quickly with the idea that this fat will come off quickly. This method is used for short-time tests. Hard-fitting is done by feeding for a little longer time and using a higher percentage of protein in the grain ration with the idea that this fat will come off more slowly and is used for yearly test-work. The usual roughage feeds are used, namely, corn silage, roots and legume hay. A typical soft-fitting grain ration would be equal parts of ground corn or barley, ground oats, wheat bran, linseed meal. The cow is usually fed all she will clean up readily. In a hard-fitting ration the same roughage feeds are used, with something like the following mixture for a grain ration: 100 pounds oats, 100 pounds corn, 100 pounds oilcake, 100 pounds bran, fifty pounds cottonseed, fifty pounds gluten feed. This mixture is often changed around in order to get an idea of the likes and dislikes of the cow so the feeder will have some idea for feeding after she freshens.

These fitting rations are discontinued about ten days before calving time, and what is known as a cooling ration is fed. More succulent feed is used in the roughage part of the ration and a laxative, bulky grain ration is fed, such as two parts bran, two parts oats, and one part oilcake. If any difficulty arises as calving time approaches, a bran mash is often resorted to. The cow should be kept warm and the bowels kept open. After calving, a bran mash should be given and the cow should not be milked dry for three or four days. After calving, the same cooling ration should be continued for a short time, gradually changing to the regular ration. Care should be taken at this time and the heavy ration should be increased very gradually. The cow's appetite should be watched and should always be kept keen. After the ration gets up to fifteen or twenty pounds of meal, the increase should not be over half-pound a day.

The ration for the test should contain the very best legume hay, silage, roots or some kind of palatable succulent roughage in abundance. The grain

ration should be high in protein-rich feed, bulky, palatable, and contain considerable variety. The following grain rations are typical:—

Ration I

Oats	100 pounds
Corn	100 "
Oilcake	100 "
Distillers' Grains	100 "
Gluten	100 "
Bran	100 "
Cottonseed	50 "

Ration II

Oats	300 pounds
Bran	400 "
Cottonseed	200 "
Gluten	300 "
Oilcake	300 "

Ration III

Distillers' grains	500 pounds
Gluten feed	300 "
Bran	200 "
Oats	200 "
Hominy	200 "
Oilcake	200 "
Cottonseed	200 "

These rations are fed in large amounts, always being careful not to overdo the cow. If a cow does not respond in the milk flow with an increased amount of meal mixture, a reduction in the ration is necessary until it is noticed that the milk flow is dropping, when it may be increased gradually again. It will be noticed that in these rations economy is not considered. The only point is to get the maximum amount of milk.

COMMON DAIRY CATTLE AILMENTS

It should be the aim of every dairyman to know something about the common ailments and diseases of dairy cattle as well as the simple preventive and curative measures. No attempt will be made to take up these diseases in detail or to give a thorough veterinary treatment. However, the most common diseases will be dealt with in order to give some of the common preventive measures.

In every dairy barn there should be the following equipment for treating sick animals:

A clinical thermometer;
A drenching bottle;
A trocar and canula;
A milk fever apparatus;
A syringe;
A funnel;
Rubber hose;
Milking tubes;
Graduated measuring glass;
Clippers.

There should also be a supply of the following common drugs:

Purgatives	Ginger, Epsom salts, Raw linseed oil, Castor oil.
Disinfectants	Creolin, zenoleum or other disinfectant, Boracic acid.
Application to udder and teats	Carbolized vaseline, Camphorated oil, Lard.
Bloating	Turpentine.
Stimulants	Tincture of gentian, Nux vomica, Tincture of iodine.

These should be kept in a medicine chest, properly labelled, while the equipment should be kept clean and ready for use.

DISEASES.

Scours.—Scours in calves are usually caused by carelessness in feeding. They are easily prevented and readily overcome but should be attended to at once. Usually they can be prevented by keeping pails and feeding utensils clean, and by careful feeding. When they appear, cut the feed in two and give about four ounces of castor oil. Also give a little linseed tea and a couple of ounces of limewater. Do not feed succulent or spoiled feeds.

White Scours.—White scours is an infectious disease caused by a germ. It is usually very serious and often fatal. The best preventive measure is to keep cow and stall clean and thoroughly disinfect before the calf is born. The best remedy is one and a half teaspoonfuls of formalin in milk every four or five hours.

Ringworm.—Ringworm is a parasitical disease and is contagious. Pull out the hairs and paint with iodine or an ointment made from mixing lard with flowers of sulphur, or with sulphur-iodine treatment.

Lice.—Throughly disinfect stables before turning cattle in with two per cent. solution of creolin or kerosene emulsion. A good practice is also to clean stable right after cattle are turned out in the spring. Dipping and washing of cattle with different materials is frequently practised. Clipping cattle is also a good practice to keep down the pest, also dusting with some insecticide powder. Sabadilla powder has given best results of any at the Ontario Agricultural College.

Tuberculosis.—Bovine tuberculosis is receiving considerable attention at the present time as it is thought that it is responsible for some of the disease in the human family. The Dominion Government is carrying on extensive work at the present time aimed at eradicating the disease.

This disease is very hard to diagnose, particularly in the early stages, and consequently very hard to get rid of in a herd. There is no known cure. The only way of getting rid of the disease is to get rid of the affected animal after isolating it by the tuberculin test.

Abortion.—Abortion may be due to accident or from an infectious disease of the reproductive organs. Too many herds have contagious abortion spread through them by taking for granted the first aborting cow was due to accident. In any case it is well to isolate the cow and burn the foetus and membranes or bury them in lime.

All surroundings should be disinfected and the cow washed off with disinfectant as well. Flush the cow's womb regularly with mild disinfectant until free from discharge.

Retention of Afterbirth.—Retained afterbirth frequently follows underfeeding. Well-fed cows do not usually give much trouble. It is also closely associated with contagious abortion. Give a warm bran mash after calving. Keep the cow warm and give physic. If the afterbirth does not come away after forty-eight hours it should be taken away by an experienced person.

Barrenness.—The inability of cows to conceive is closely associated with abortion, both being the result of diseased genital organs. Very often cysts will be found on the ovaries of barren cows. By manipulation by experienced veterinarians these may be broken down and conception will follow. If taken in time they may often be restored as regular breeders. This requires the skill of an experienced man and only valuable cows are really worth treatment.

Bloat.—Bloat is usually caused by sudden change of feed or overeating of such feeds as frozen grass, turnip tops or wet clover. Swelling will be noticed on the left side of the abdomen. The animal is uneasy and breathing is difficult. The nostrils are distended and the animal frequently moans or belches.

In mild cases give two to four ounces of turpentine in a pint of linseed oil. This may be repeated in an hour's time. In extreme cases the only cure is to puncture with the trochar and canula between the point of the hip and the last rib on the animal's left side.

Milk Fever.—Milk fever is a common and apparently inevitable trouble with good cows. Heavy feeding just before parturition tends to bring about the trouble. It usually happens within twenty-four hours after calving. The cow becomes drowsy, has no appetite, her eyes are dull and staring. She sways and stumbles when walking and eventually falls and is unable to rise except on her front feet. She usually lies with her head turned around to her side. The cow, in this condition, is partially paralyzed and cannot swallow, so it is useless to try and drench. The only treatment is to inflate the udder with air or oxygen and tie the teats. Give a stimulant such as nux vomica, two ounces, and alcohol, six ounces, in one-ounce doses four times a day.

Garget or Mammitis.—A slight congestion of the udder is normal at calving time, but exposure to cold or drafts or after-neglect may bring on an aggravated inflammation. The udder becomes very hot, is inflamed and hard. Milk-secretion is impeded or the milk shows clots or streaks of blood.

Give the cow a physic. Bathe the udder with hot water. Massage the udder and apply camphorated oil. The milk should be frequently drawn.

Cowpox.—Small blisters form on the teats, containing a yellowish fluid. The trouble is contagious so infected cows should be milked last. Apply carbolized vaseline.

Foul in the Foot.—Foul in the foot is an infection in the clefts of the feet of cattle. It usually arises in the stable but sometimes occurs while on pasture. Cleanliness is the best preventive.

The affected foot should be cleaned thoroughly. Apply strong solution of copper sulphate or butter of antimony. For severe cases a poultice is necessary. Give a purgative. Powdered boracic acid dusted into the clefts helps to dry and heal the sore.

Teat Troubles—Leaky teats are due to the sphincter muscle at the end of the teat being too slack. It is very hard to cure. Hard milking is due to the sphincter muscle being too tense. This can be cured by dilating the muscle with a teat plug.

A fibrous growth may sometimes completely close the teat. Very little can be done for this.

A hole in the teat may be remedied when the cow is dry by scarifying the tissue around the opening and stitching it up so that it heals over.

FLY SPRAY

1¼ quarts of coal tar dip (Zenoleum);
1½ quarts of fish oil;
1 pint of tar;
1 quart of coal oil;
½ pint of pennyroyal.

Mix in ten gallons of lukewarm soft water in which a bar of laundry soap has been dissolved. This mixture is not perfect but as good as most home-made fly sprays. It leaves the coat rather harsh and causes dust to adhere.

Greasy and oily repellants give more protection but may be objectionable as they clog the pores of the cow's skin.

Flybane is rather expensive but is one of the most effective repellants used at the Ontario Agricultural College and there is no injury to the skin and hair.

PROBLEMS IN BREEDING

Successful dairy farming depends on successful breeding as well as intelligent feeding. It is impossible to make a poor cow good by feeding, so it is necessary to first have a cow that has the ability to produce milk. Then, by intelligent feeding it is possible to produce milk economically.

Foundation Stock.—If the prospective dairy farmer has no animals of any sort, and is free to select, it is very important that he bear in mind clearly the value of the dairy-type animal. That is, one showing capacity for consuming feed, with lean, angular form denoting an absence of too great a flesh-forming tendency, with udder and milk veins well developed and with an alert temperament and strong constitution. It should also be borne in mind that he is more likely to find this type if grades of some standard dairy breeds are selected. Haecker, of the Minnestota Experimental Station, divided the state herds into four groups, depending on type and conformation. Group 1 was composed of distinctly dairy-type cows with deep bodies. These required 21.2 pounds of dry matter in the feed to produce one pound of butter fat. Group 2 was composed of dairy-type cows but lacked depth of body. These required 25.5 pounds of dry matter to produce one pound of butter fat. Group 3 was composed of cows showing some inclination toward beefiness and required 26.4 pounds dry matter; and the fourth group, which were of distinctly beef type, required 31.3 pounds of dry matter for each pound of butter fat produced. This goes to show that the beef-type cows required forty-seven per cent. more feed to produce a pound of butter fat.

If the prospective dairy farmer has on hand a herd of cows of unknown ability, he should at once take steps to find the profitable cows. A very poor cow is no better than no cow at all and should be disposed of at once. After that, the calves from the best cows should be raised and if a good pure-bred bull is kept, considerable improvement should be noticed with each generation.

Breed to Keep.—Considerable attention should be given to the selection of the breed, whether they are pure-bred or grades. Generally speaking, the breed to keep is one of the well-established breeds that is most common in the immediate neighbourhood where the particular farmer is located. Community breeding has many advantages and should be practised wherever possible. A community noted for one breed of stock attracts more buyers and the farmer finds it easier to dispose of his surplus stock. The breeds most common in Ontario are the Holstein, Ayrshire and Jersey, and each have some points that make them attractive to the farmer. The Holstein, as a breed, leads in the yield of milk and outnumbers the other dairy breeds in Ontario. It is estimated that there are 60,000 registered Holsteins in the Province. Besides this, they lead other breeds in the number of grades. That the Jerseys are popular in Ontario to-day is demonstrated by the fact that the demand is much greater than the supply. It is estimated that there are 12,000 registered Jerseys in Ontario. The Ayrshire is about half-way between the Jersey and Holstein. They yield, as a breed, more milk than the Jersey and a richer milk than the Holstein. The breeders of Ayrshires do not aim at phenomenal tests but seek to keep average for production and type always foremost. That they are succeeding can be seen in any show ring or by looking over the test records for the breed. There are

about 20,000 Ayrshires in Ontario. The Guernsey is also receiving some attention in Ontario and in all probability will hold an important place in the future.

Selection of the Bull.—In starting a herd of dairy cows, there is no single problem of greater importance and none which offers greater difficulties than the selection of a herd bull. Too many farmers forget that the bull is half of every offspring produced in the herd. With a poor cow in the herd you get one poor calf; with a poor bull you are liable to get all poor calves. Whether the herd is grade or pure-bred, nothing but a pure-bred bull should be kept. He should be a good individual, having plenty of constitution, vigour and masculinity, and should be true to the type of the breed he represents. Of equal importance to the individuality of the bull is his pedigree. He should be from stock that have demonstrated their ability to produce milk.

Pure-bred or Grade.—A question that is often asked is whether the farmer should keep pure-bred or grade stock on the dairy farm. Generally speaking, the average man should commence with grades and work into pure-breds gradually. If, on the other hand, the farmer has experience with live stock and knows how to handle them, he may find he is able to make larger returns from a pure-bred herd. It should, however, always be borne in mind that the same care in selection is necessary with pure-breds as with grades. Not all pure-bred animals are producers and it too often occurs that the beginner will buy cheap pure-bred stock and usually find that they are not profitable.

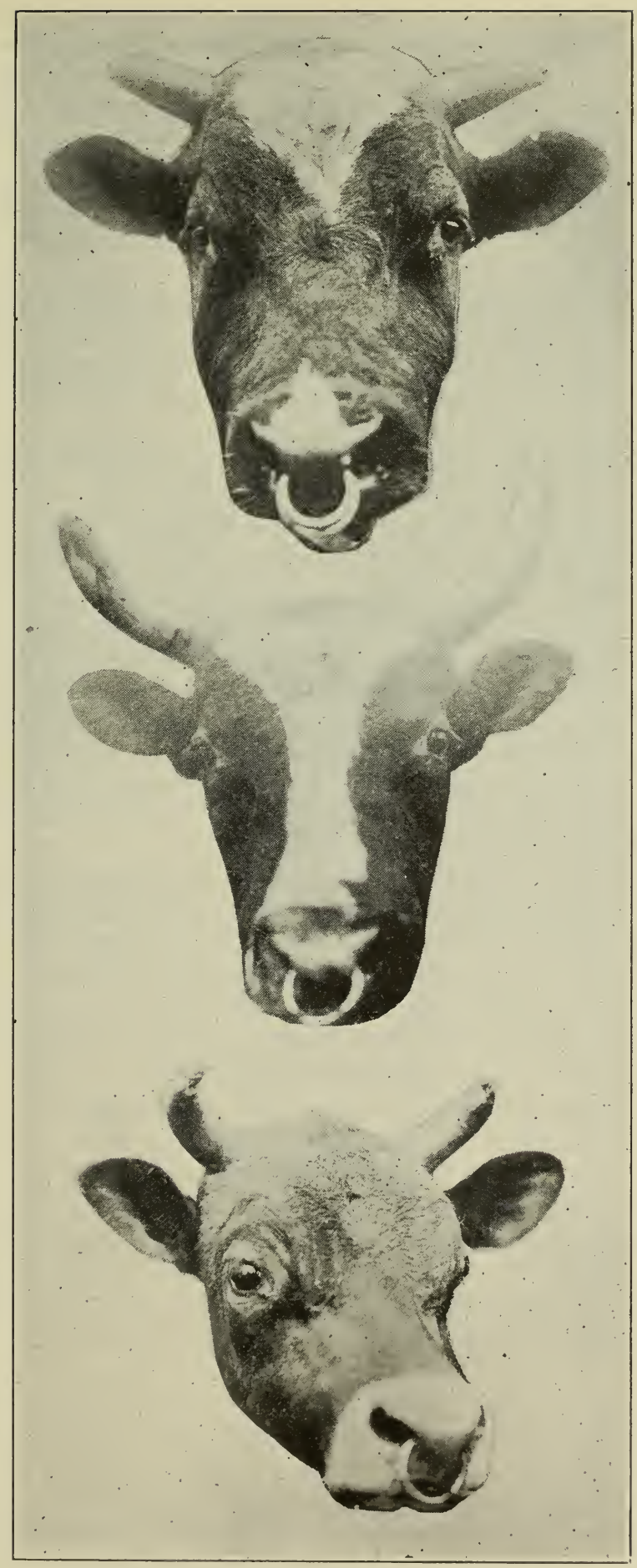
Breed Families.—In buying pure-breds it should be borne in mind that certain strains or families are much better than others. The old saying, "That it is the strain rather than the breed," is very true. Breeders should buy animals from good strains or families for best results, paying particular attention to the top crosses or the last few generations.

Certain types of breeding should be mentioned, such as grading, crossing, pure-breeding, line-breeding and inbreeding.

Grading.—Grading-up means the mating of grade cows with a pure-bred bull and is usually the way the average breeder starts the improvement of his herd. After the first generation the best heifers are bred to a pure-bred bull of the same breed. This method, kept going for a few generations, works marvels on the appearance of the herd, and, if good bulls are selected, improves the milking qualities as well. The following table points out very clearly how the grade blood gradually disappears:—

Generations	Sire's per cent. of purity	Dam's per cent. of purity	Offspring's per cent. of purity	Percentage of unimproved
1	100	0	50	50
2	100	50	75	25
3	100	75	87.5	12.5
4	100	87.5	93.75	6.25
5	100	93.75	96.87	3.12
6	100	96.87	98.44	1.56

This method is a cheap way of improving the herd as the only outlay is for a pure-bred bull. No graded-up sire should be used or no other breed should be introduced, or the work of grading-up very quickly goes back to where it was at the start. It is possible, if careful selection is practised, to build up an excellent producing herd in a very few generations by grading.



One of the Indications of a Prepotent Sire.
Heads of Holstein, Ayrshire and Jersey Sires at O.A.C., showing Breed Character, Dairy Type and Masculinity.

An example of this was some work done at the Iowa Experiment Station. Professors Kildee and McCandlish carried on some work in grading up a herd for milk production. They started with scrub cows of no particular breeding, and with good care and feed produced an average of 3,867 pounds of milk, containing 172 pounds of fat. The daughters from these cows out of pure-bred bulls gave on the average 5,945 pounds of milk and 267 pounds of fat. The granddaughters of these same cows, carrying three-quarters of pure-bred dairy blood, averaged 8,311 pounds of milk and 371 pounds fat, an increase of 116 per cent. in yield of milk and 106 per cent. of fat in two generations.

Crossing.—Cross-breeding is the mating of a pure-bred with a pure-bred of another breed. It is supposed to produce hardier livestock than pure-breeding and is sometimes followed to produce stock for market purposes. In dairy-cattle breeding, crossing has no place and should never be practised under any consideration.

Pure-breeding.—Pure-breeding is the term applied to the breeding of a pure-bred female to a pure-bred bull of the same breed. There are several different systems followed, the most common being the breeding of males and females not closely related. This is probably the safest for beginners and the general run of farmers.

Line-breeding.—In line-breeding the breeder selects males and females of the same blood lines or animals of the same strain or family. By this means the breeder is able to get a concentration of blood which gives a more powerful hereditary influence. Line-bred animals usually have a stronger influence on the offspring than animals that are not line-bred. A great many of the most noted sires have been line-bred individuals. Line-breeding is the safest and best system of improvement but can only be practised by experienced breeders, as individual selection must be practised as well.

Inbreeding.—Line-breeding is the mating of individuals remotely related, not closer than cousins, while inbreeding refers to the mating of close relatives such as sire and daughter or son and dam or brother and sister. This kind of breeding should never be practised by the beginner and only to a very limited extent by the experienced breeder. Inbreeding tends to concentrate the blood and brings out desirable qualities but is apt to multiply the defects as well. It may also result in loss of vigour and low fertility in the offspring.

The Good Breeder.—Few farmers realize the importance of keeping the successful breeding animal on the farm. The good milker that is a regular breeder is the cow which no farmer can afford to sell. Fertility is a very important factor in all classes of live stock and is an inherited character. Lack of vigour and failure to breed regularly is one of the commonest defects in our live stock to-day. While milk production is important in the dairy herd, ability to reproduce is just as important, and where these two desirable qualities are combined in one individual, they make that individual doubly valuable and such an animal no farmer can afford to sell.

Cull Out Unprofitable Cows.—Even in the best dairy districts, probably one quarter of the dairy cows fail to pay their way. If this is true in these districts, what percentage would be in the "boarder" class in some of the other districts? The reason that there is this high percentage in good districts is because no one can tell by appearances whether a cow is profitable or not. The only satisfactory way to ascertain is by the milk scale and the Babcock tester. Knowing the actual production of each cow and the approximate amount of feed consumed in a given period, the farmer is able to size up his profitable cows and

in a few years get rid of those that do not pay a profit over feed consumed. Care should be taken, however, as good cows often have a bad year and it might often be well to give some cows a second chance.

Young or Mature Bull.—Breeders of live stock should pay more attention to the use of proven sires. Dairy-cattle breeders will find proven sires the cheapest way of building up dairy herds. Too many good sires are sold for beef before their real value is known. The young bull can usually be bought cheaper than the old bull with tested daughters and is usually easier to handle. There are, however, so many disadvantages in the young and untried sire that they more than make up for the extra cost and care in handling. The young bull is untried and the buyer must wait about three years after he is old enough for service before his merits as a sire can be known. If he proves to be an inferior sire and has been in a herd during that time, he will have almost ruined it. One can never be sure how a young bull will develop. Some choice type calves develop into ungainly animals.

PERSISTENCY OF MILK FLOW

It is very easy to be deceived in the yearly production of cows that give a liberal flow of milk for a time after calving but fall off greatly in their yield afterwards. To prove profitable, a cow must produce well during a long lactation period. Persistency may be illustrated by the average record of ten good cows, representing several dairy breeds and calving at different times of the year. Calculated from R.O.P. reports, the average milk production of these ten cows for each month after calving was as follows:—

1st month after freshening	1,664
2nd " " "	1,710
3rd " " "	1,641
4th " " "	1,553
5th " " "	1,387
6th " " "	1,414
7th " " "	1,269
8th " " "	1,167
9th " " "	1,010
10th " " "	925
11th " " "	826
12th " " "	695
Total	15,261

CLEAN MILK

Milk is one of the most healthy foods if handled properly, but no food is so easily contaminated if not properly handled. It costs very little more to produce clean milk and the result is a better-keeping product and a higher-priced product.

Clean milk can be produced only by observing the following essentials:—

Healthy Cows.—The cattle should be free from tuberculosis and other contagious diseases, skin diseases and parasites.

Clean Cattle and Stables.—The stables should be cleaned regularly. Twice a day is preferable. Calf-pens and box-stalls should be cleaned at least twice a week. The cattle should be brushed off once a day. Cobwebs and dust should not be allowed to collect on the ceilings and walls and all dusty forages should be swept up after feeding.

Good Barns.—The barn should be easy to keep cleaned out. The walls, ceiling and floors should be smooth so as not to collect dirt. Plenty of light and good ventilation is essential.

Clean Milking.—The cows should be bedded at least half an hour before milking and the udders and flanks brushed off with a clean damp cloth just before milking. The milkers should wear white jackets or aprons which should be kept clean. The hands should be clean, and milk should not be used to dampen the teats. The cows should be milked quickly, gently and thoroughly.

Clean Bedding.—Clean straw or shavings make excellent bedding while dusty straw or chaff from the haymow mean a dusty barn and dirty milk.

Clean Utensils.—Milk pails, cans, separators and all other utensils used for milk must be thoroughly washed and scalded twice per day and well aired in a room free from dust and flies. It is well to use a good washing powder in the wash-water and scald with pure scalding water.

Milk Handled Quickly.—It is better not to leave milk in the stable or to pour it in the stable after being drawn from the cows. It should be weighed and poured into cans in a clean room adjoining the barn. Milk should be cooled as quickly as possible. Ice is indispensable on a dairy farm in the summer in order to keep milk at a low temperature until delivered to the factory, milk dealer or consumer.

DAIRY STABLES

Good, comfortable buildings are absolutely necessary to make dairy farming a success in Ontario. These should be convenient, comfortable, dry, easily ventilated and easy to keep clean. Fancy architecture is unnecessary and only adds to the overhead of the farmer. Good, plain buildings with the essentials for the proper housing of the stock and the storing of feed are all that is necessary.

The following outlines should assist the farmer who is thinking of remodelling old stables or building new:

The location should be high and dry. If possible, build in the lee of a windbreak.

Fifty to sixty feet of floor space is necessary for animals of all ages, and from 500 to 600 cubic feet of air space per cow.

Storage space for feed should be from 900 to 1,000 cubic feet; for silage, 150 to 175 cubic feet per head.

From four to five square feet of window space should be provided per cow, as plenty of light is essential. Windows should be hinged at the bottom so they will open at the top. This will allow fresh air to come in at the top so that there will be no direct draft on the cows.

Provide plenty of ventilation. About eight square inches of inlet area per head is necessary, and fifteen square inches of outlet. The inlet should be not less than 12 inches by 6 inches in size of opening, larger is better; the outlets, 15 inches by 15 inches. Smaller outlets cause too much friction and interfere with the smooth flow of air.

The best material for floors is cement. These should be at least six inches in thickness. An insulating layer in the cement makes the floor dry and warm. This can be provided by putting a layer of tar paper or a coat of tar in between the two layers of cement. The finish of the floor should be rough and any sloping parts should be avoided to overcome the danger of cows slipping. Sprinkling ground limestone on the floors and passages once daily effectively prevents slipping. Keep everything as nearly level as possible, but sufficient slope for drainage should be provided.

The walls of the stable are important. Cement is very satisfactory, but for best results it should be studded up on the inside and lined with boards. Hollow cement blocks make a very satisfactory wall. Where lumber is available, nothing

will serve better as it makes a particularly dry stable. A cement foundation, rising a foot to eighteen inches above the ground, a double coating of lumber with paper between outside and boarded up with matched lumber inside makes an ideal stable wall.

While it is not absolutely necessary to board over the ceiling, yet, where expense is not too great, a tight ceiling is an advantage. It is easier to keep clean and is much drier.

Cow-stalls should be 3 feet 6 inches in width. The length of the stand from manger to gutter varies with the size of cow, from 4 feet 6 inches for young cattle and small cows to 5 feet 9 inches for large ones. A good plan is to make it the maximum length at one end and narrow it down to the minimum at the other where the herd to be stabled varies in size.

Ontario Agricultural College Dairy Barn.

Mangers may very profitably be made of concrete. They should be wider at the top than at the bottom with the corners at the bottom rounded so there is no place for dirt to accumulate. The bottom of the manger should be about two inches higher than the cow's feet. They should also slant towards the cow, being wider at the top than at the bottom.

A passage, either in front or behind a single row of cows, should be five feet wide. A passage, either in front or behind two rows of cows, should be about seven feet wide.

Plenty of box-stall room is necessary. A good size is ten feet by ten feet, or larger, if there is sufficient space available. A few smaller stalls for calves may often be worked in to advantage. Partitions between box-stalls should be five feet high.

The gutter should be eighteen inches wide and six or seven inches deep. It should be square, with a gentle slope to one end of the stable, one to two inches in fifty feet.

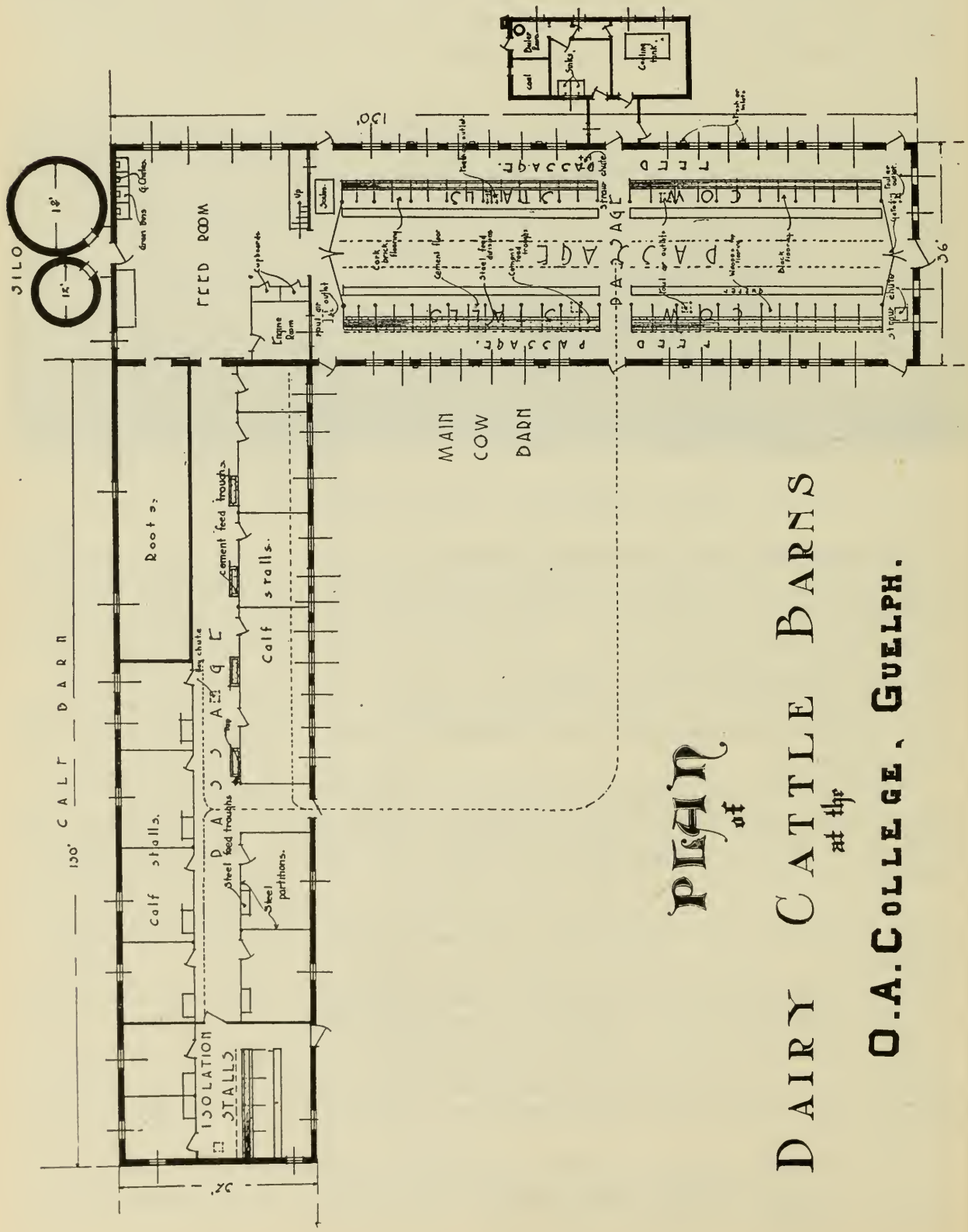
Stanchion ties are recommended for dairy cattle as an aid to cleanliness, but possibly double-chain ties may prove more comfortable for large, heavy cows.

Dairy cattle should be housed separate from other classes of farm stock, if possible. A T- or L-shaped barn will make this possible on a farm where all classes of stock are housed in the one barn. One wing should be given over to the dairy herd.

A total width of thirty-six feet is sufficient to provide plenty of room for two rows of cow-stalls. When a barn is wider than this it might be advantageous to run the stables crosswise.

With a concrete manger and water in the stable, the cows can be watered conveniently by running water in the manger if a drain is provided at the lower end. This necessitates keeping the manger clean at all times and is an advantage. The water used is always fresh. It is also cheaper than to install special watertroughs or individual drinking bowls.

The following is a plan of the dairy stable at the Ontario Agricultural College.


PLAN
of
DAIRY CATTLE BARNS
at the
O.A.COLLEGE, GUELPH.
MAIN COW BARN
CALF BARN
FEED ROOM
SILO
Root s.
Calf stalls.
Cement feed troughs
Steel feed troughs
Steel partitions.
ISOLATION STALLS
Engine Room
Straw chute
Coal
Cutting Box
Cement floor
Steel feed troughs
Cement feed troughs
Cork brick flooring
Block flooring
Wooden flooring
Fodder chute
Feed chute
Fodder chute
Water trough
Green bins
Cutter
Up
Down
Stairs
Fodder chute
Straw chute
Feed chute
Hay chute
Feed chute
Fodder chute
Straw chute
Fodder chute
Water trough
Feed chute
Fodder chute
Straw chute
Feed chute
Fodder chute
Straw chute
Feed chute
Fodder chute
Straw chute

BULLETIN 312] [AUGUST, 1925

Ontario Department of Agriculture

WOMEN'S INSTITUTES BRANCH

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VEGETABLES

THEIR FOOD VALUE AND PREPARATION

VEGETABLES IN THE FAMILY BILL OF FARE.

Vegetables were never intended to be used merely as an addition, a sort of garnish, to a meal of meat. They meet special, indispensable requirements in the dietary which no other foods can supply, and if they are to do this fully, they must be used *in abundance* and *in variety*.

Vegetables Act as Blood Regulators.

It is most important that the blood be kept alkaline. This can be done by liberal use of fruits and vegetables. Although a number of these contain a great deal of acid in themselves, after digestion they give to the blood certain mineral matter which makes it alkaline. Vegetables which help most in this respect are spinach, celery, chard, lettuce, tomatoes, fresh cucumbers, carrots, cabbage, cauliflower, string beans, beets, parsnips, dry lima beans, radishes, mushrooms, potatoes, turnips, asparagus, onions, peas.

Vegetables Furnish Iron.

Vegetables are one of the best sources of iron for good red blood. Those especially rich in iron are spinach, dandelion greens, chard, watercress, cabbage, Brussels sprouts, asparagus, string beans.

Vegetables Supply Vitamin for Growth and Health.

Not many years ago it was discovered that green vegetables, fruits, milk and milk products along with certain other foods contain a special substance necessary to growth and health. These substances were called vitamines. By experiments in the feeding of animals it was found that when deprived of these health-giving substances, growth was retarded or stopped entirely and the general health showed a steady breakdown. When the vitamin foods were again given, there was almost immediate evidence of positive improvement in

health. Some of the vegetables rich in these vitamines are the green leaf vegetables, such as lettuce, celery and raw cabbage. Tomatoes, too, are among the most important of the vitamin vegetables.

Vegetables Aid in Eliminating Poisons.

While the mineral salts and acids in vegetables are better tonics and blood-builders than the most expensive prescription to be had at a druggist's, the coarse fibrous material in the "leaf and stalk" vegetables will do more to prevent constipation and to keep the body free of poisonous waste than any artificial methods. Spinach contains so much of this fibrous material that it has been called "the broom of the digestive tract."

Certain Vegetables Help to Build Muscle.

Leguminous plants contain a high proportion of protein or body-building material. A leguminous plant has little nodules on its roots through which it gathers nitrogen from the air, and stores it in the plant, seeds, stalks, roots and all. The common leguminous plants in this country are the clovers, beans and peas. Since nitrogen is the chief element in protein this explains why a crop of clover or white beans enriches the soil, and why dried white beans are so rich in protein that they have been called "the poor man's meat." The legume vegetables, beans, peas and lentils, contain a fair amount of starch as well as protein and a considerable quantity of lime. Some of the seed vegetables also contain a certain amount of building material, but these are usually classed as cereals rather than vegetables.

Certain Vegetables Supply Fuel to the Body.

Starch, sugar and fat are the chief principles that supply the body with fuel for heat and energy. The vegetable foods rich in starch and sugar are roots and tubers, such as potatoes, parsnips, carrots, beets and salsify, also those vegetables where the seed is used, as in corn, beans and peas. Since vegetables contain so many health-giving by-products as mentioned above, it is well to get a large proportion of our fuel from them rather than from too much white bread and the fat of meats.

Starch and Sugar Values of Vegetables.

Up to 5% Starch and Sugar.—Vegetables containing the least starch and sugar up to those containing 5% are, lettuce, cucumbers, spinach, chard, asparagus, rhubarb, endive, vegetable marrow, beet greens, celery, tomatoes, water-cress, sea-kale, cauliflower, egg-plant, cabbage, sauer-kraut, Brussels sprouts, onions and radishes.

With 5-10% Starch and Sugar.—String beans, turnips, Kohl-rabi, squash, beets, carrots and salsify.

With 10-15% Starch and Sugar.—Beets, potatoes, corn, parsnips, lima beans green, dried lima beans, dried white beans and dried peas all contain more than 15% of starch and sugar.

HOUSEHOLD RULES FOR THE USE OF VEGETABLES.

Knowing that vegetables are essential to health, that when used in variety, well-cooked or served raw in salads, they add infinitely to the interest and palatability of the meal; and that those rich in starch and sugar supply an appreciable quantity of actual nutriment, the following set of household rules will not seem unreasonable to the thinking housewife:

1. Every day use one green or one yellow vegetable or tomatoes.
2. Every day use a raw vegetable, a raw fruit or a cooked acid fruit.
3. Every day use one leafy vegetable.
4. Every day use one starchy vegetable.
5. Every day use two vegetables other than potatoes or dried beans.
6. Every day use a cooked vegetable with milk—creamed soup, creamed vegetable, au gratin or escalloped.
7. Every day use vegetables which are rich in alkaline salts to serve with meats (See paragraph "Vegetables act as Blood Regulators).
8. Every day use vegetables rich in vitamines—tomatoes or green, leafy vegetables.
9. Use liquid in which vegetables are cooked for soups or sauces.
10. Every summer can vegetables for winter use, particularly tomatoes.
11. Have a good kitchen garden. If this is impossible, as in the case of some city homes, spend at least one-fifth of the food budget for fruits and vegetables.

Methods in Vegetable Cookery.

Baking.—Any tough-skin fruit or vegetable may be baked in the oven. Potatoes may be oiled with bacon fat before baking to keep the skin soft. Squash is usually cut into serving portions before baking. Cooking by baking saves most of the mineral matter; if the skin of the vegetable or fruit is also eaten, there is no loss of mineral.

Boiling.—Boiling in water results in the loss of a certain amount of mineral matter. The greater the quantity of water and the smaller the pieces into which the vegetable is cut, the greater will be the loss of minerals and sugar. This loss may be overcome through using the water for soup, gravy or a sauce for the vegetable. In the case of certain strong-flavoured vegetables, it may be necessary for the sake of flavour to drain off the first water. Never soak cut vegetables. (Old or withered vegetables may be soaked before paring.)

For mild-flavoured vegetables, put into boiling water to cover, bring quickly to boiling point, boil gently until tender. Add salt when vegetables are half cooked. For very strong-flavoured vegetables, put into a large amount of boiling water; cook uncovered; change water at end of ten minutes; add salt when vegetables are half cooked.

For watery vegetables like spinach and tomatoes, place in kettle over gentle heat; heat gradually until water is extracted. Cook until tender. Uncover if necessary to let water evaporate.

Steaming.—Steaming saves vital value in cooking fruits and vegetables.

Stewing.—Because all the liquid is used this method does not waste the mineral matter.

Buttered.—Any cooked vegetable may be enriched with melted butter, salt and pepper. Allow the water to evaporate as the cooking continues. It may be necessary to drain off what remains at the last, then add butter, salt and pepper and reheat before serving.

Creamed.—Make a white sauce using two tablespoons butter, one tablespoon flour, one cup milk, one-half teaspoon salt and one-quarter teaspoon pepper. Melt the butter, add the flour, mix thoroughly; add milk, stir as it cooks until it thickens and boils. Add salt and pepper.

One cup of the sauce is used with two cups of vegetables. Any steamed or boiled and drained vegetables may be served hot in cream sauce.

Escalloped.—Cooked or raw vegetables are placed in a buttered baking dish in alternate layers of the vegetables and bread crumbs with bits of butter, the top being covered with buttered crumbs. Milk is added to come nearly to the top of the crumbs and the dish is baked in a moderate oven until thoroughly cooked and browned on top. In the case of raw potatoes, the layers of potatoes are dredged with flour and dotted with butter and sprinkled with salt and pepper, crumbs being used only on top. Cooked vegetables, except tomatoes, may be combined with a white sauce, covered with bread crumbs and cooked in the oven until heated through and the crumbs browned.

Au Gratin.—Make a white sauce; place the cooked vegetables in a buttered baking dish in alternate layers with white sauce and a sprinkling of grated cheese. Cover with bread or cracker crumbs and grated cheese. Bake in a moderate oven for about twenty minutes.

Croquettes.—Make a thick white sauce, using four tablespoons of flour to one cup of milk, combine with chopped or mashed cooked vegetable, mould into shapes, dip in beaten egg white and fine bread or cracker crumbs. Fry in deep fat or bake in the oven.

Glazed.—Boiled carrots, parsnips or sweet potatoes are cut in fairly large pieces and placed in a single layer in a baking dish. Sprinkle with a little brown sugar and water, or with a syrup of boiled cider or maple syrup. Bake until brown, basting often.

Chowder.—Cut up a few strips of bacon and fry, adding chopped onions and stirring until the onions are slightly brown. Add such vegetables as diced carrots or turnips and potatoes with enough boiling water to cover. When vegetables are tender, add milk and, if necessary, salt. Bring to boiling point. Break crackers into a serving dish, pour over the chowder and serve at once.

Soups.—For Vegetable Cream Soup, make a thin white sauce, using one tablespoon of flour to one cup milk. To this add the vegetables which have been cooked and pressed through a sieve. The water in which the vegetables were cooked may be used in place of one-half of the milk in making the white sauce. Reheat and serve.

Cream of Potato Soup may be made from milk, salt, pepper, mashed potatoes and onions, without flour, though it is not so smooth. The onions should be chopped fine and scalded with the milk, or may be grated into the soup mixture.

Cream of Tomato Soup. Take canned or raw tomatoes, cook with seasonings until very soft, press through a sieve. To two cups tomato add one-eighth teaspoon soda. Add two cups hot milk, two tablespoons butter and reheat.

Salads.—Knowing the health value of green vegetables, the wise dietitian will try to keep her household generously supplied with salads throughout the year. Raw vegetables, of course, contain certain valuable food substances that are lost in the process of cooking. Cooking also softens the "cellulose" or fibrous material, making the vegetables less valuable as a bulky or ballast food. With a good kitchen garden, it is not difficult to have a good variety of raw salads from early summer until fall. During the winter the farm housekeeper may have to depend largely on apples, cabbage, celery, onion and grated carrot for raw salad materials, with, of course, potatoes, beets and tomatoes canned whole for the staples in cooked materials. Without any greenhouse supplies, it is easy to have some "greens" throughout the winter by keeping a pot of parsley growing in the kitchen window.

As salads are usually served with a dressing made up largely of cream or oil, they have an appreciable food value. When nuts are added they contribute a certain amount of protein. A salad, then, eaten with bread and butter and a glass of milk, makes a very well-balanced meal.

A special section on salads is given later in this bulletin.

SPECIAL VEGETABLE RECIPES.

Escalloped Potatoes.

Into a baking dish slice a layer of raw potatoes, sprinkle with salt, pepper and bits of butter. Dredge with flour. Add another layer of potatoes and repeat until the dish is full. A few slices of onion may be added. Pour over scalded milk to come just to the top of the potatoes and cook in a rather slow oven.

Escalloped Potatoes with Bacon.

Omit butter from escalloped potatoes; place strips of bacon in layers with potatoes, having potatoes on top. Add milk and cook as above.

Potatoes au Gratin.

Make a white sauce. Cut cold boiled potatoes in dice. Put in a baking dish, sprinkle with salt and pepper; pour over the white sauce. Sprinkle with grated cheese and cook in the oven until heated through and browned on top.

Pan Browned Potatoes.

Pare potatoes and parboil ten minutes. Drain and put in pan in which meat is roasting. Bake until soft, basting with fat in pan when basting meat. Bake about forty minutes. Onions, carrots, parsnips and turnips may be cooked in the same way.

Potato Puff.

Take two cups mashed potatoes, one egg, two tablespoons butter, three-fourths to one cup of milk, salt and pepper. Separate the egg, beat the yolk, add to the potato, milk, melted butter and seasonings and beat again. Fold in the stifly-beaten egg white and bake in a buttered dish until nicely browned.

French Fried Potatoes.

Wash and pare small potatoes, cut in eighths lengthwise and soak one hour in cold water. Take from water, dry in towels and fry in deep fat. Drain on brown paper and sprinkle with salt.

Creamed Potatoes.

Cut cold boiled potatoes in dice and reheat in white sauce, using two cups potatoes to one and one-fourth cups sauce.

Stuffed Potatoes.

Bake large potatoes. For six potatoes take two tablespoons butter, four tablespoons milk, salt and pepper. Cut a slice off the top of each potato, scoop out the pulp and beat up with the melted butter, milk and seasonings. Pile into the shells and reheat in the oven until lightly browned on top.

Boiled Onions.

Use small or medium-sized onions if they are to be cooked whole. Put in a saucepan, cover with boiling salted water, and if they are very "strong" drain after they have boiled for five minutes. Again cover with boiling salted water, cook until soft, drain. Add a small quantity of milk, reheat, add butter, pepper and salt, and serve.

Spinach, Chard, Beet Greens.

Remove roots and coarse stems from one-half peck of spinach, pick over and wash in several waters. Shake from the water, put in kettle and heat slowly until juice is extracted. Cook until soft, stirring frequently to prevent burning. Do not add water unless it is necessary. Drain, chop leaves. Add two tablespoons butter, salt and pepper. Serve plain or garnished with toast points and hard-cooked eggs. Chard and beet greens may be cooked in the same way.

Asparagus.

Cut off lower parts of stalks as far down as they will snap. Untie bunches, wash, remove scales and retie. Cook in boiling salted water for fifteen minutes, leaving the tips just above the surface. Drain, remove string and spread with soft butter, or serve with drawn butter sauce. Asparagus is often cut in pieces for boiling. It may be served in a white sauce on toast.

Drawn Butter Sauce.

Melt three tablespoons butter, stir in two tablespoons flour, one-half teaspoon salt, and pepper. Add one cup boiling water and stir over the fire until it thickens and boils. (If this sauce is to be used for fish, add one-half tablespoon vinegar or lemon juice.)

Browned Parsnips.

Boil parsnips, cut in slices one-half inch thick, brown in a hot greased pan or in the oven with roasting meat. Left-over parsnips may be prepared in this way.

Parsnip Fritters.

Boil parsnips and mash them. Season with salt, pepper and butter. Shape into cakes, roll in flour and brown in a hot frying pan with a little butter.

Corn a la Southern.

Take two cups canned corn or corn which has been boiled and cut from the cob, two eggs, two tablespoons melted butter, two tablespoons sugar, one teas spoon salt, pepper and two cups hot milk. Add the beaten eggs to the corn; add the other ingredients. Turn into a buttered pudding dish, set in a pan of water and bake in a slow oven until firm.

Corn Fritters.

Take one cup canned corn, one cup flour, one teaspoon baking powder, one and one-half teaspoons salt, one-quarter teaspoon paprika, speck of cayenne, two eggs. Chop the corn, add flour sifted with baking powder and seasonings. Add yolks of eggs well-beaten and fold in the stiffly-beaten whites. Drop by spoonfuls in hot fat which will brown a cube of bread in one minute. Fry until golden brown.

Corn Oysters.

To one cup cooked corn, add one well-beaten egg and one-quarter cup flour and season well with salt and pepper. Drop by spoonfuls on a hot, well-greased griddle. When browned on the bottom, turn and brown the other side.

Succotash.

Cut hot boiled corn from the cob; add an equal quantity of hot, boiled shelled beans. Season with butter and salt. Reheat before serving.

Fried Egg-Plant.

Pare an egg plant and cut in slices about one-fourth of an inch thick. Sprinkle with salt and pile on a plate. Cover with a weight and press out the juice and let stand one and one-half hours. Dredge with flour and saute slowly in butter until crisp and brown.

Boiled White or Lima Beans.

Soak beans over night in cold water to which a teaspoonful of baking soda has been added. Drain, add fresh cold water (with soda if the beans are old), bring to boiling point, boil ten minutes and drain. Add boiling water and salt, cook until the beans are tender and season with butter, salt and pepper. Before adding the butter, an onion may be chopped into it, cooked until clear and yellow and added to the beans just before serving.

Lima Bean and Tomato Scallop.

Soak beans over night in cold water. In the morning drain and cook slowly in salted water. When the beans are cooked, butter a baking dish and put in alternate layers of beans and well-seasoned canned or stewed tomatoes. Dot over with butter and put in the oven to reheat. A sprinkling of grated cheese may be put over the top.

Baked Beans.

Take four cups white beans, one-quarter pound fat salt pork or a few slices of bacon, two-thirds tablespoon salt, one tablespoon molasses, two tablespoons brown sugar, one-quarter teaspoon pepper, one teaspoon mustard. Pick over and wash the beans, soak over night in cold water to which baking soda has been added. Drain, add fresh water and cook until the skins curl and break. Drain, scald and scrape rind of pork. Put a thin slice of pork in the bottom of the bean crock, turn in the beans, bury the remaining pork at the top of the crock. Mix molasses, sugar and seasonings with one cup boiling water. Pour over the beans, add enough more boiling water to cover the beans. Cover, bake in a slow oven for six to eight hours, uncover the last hour to brown the top. Add water as needed during the cooking, or add stewed and strained tomatoes or tomato catsup, during the last hour of cooking.

Creamed Cauliflower.

Remove leaves, cut off stalk and soak thirty minutes (head down) in cold, salted water to cover. Cook, head up, twenty minutes, or until soft, in boiling salted water; drain, separate flowerets and reheat in white sauce.

Cauliflower au Gratin.

Prepare and cook cauliflower as above. Place the whole cauliflower on a dish for serving, sprinkle with grated cheese, cover with buttered crumbs and place on oven grate to brown crumbs. Or prepare as for creamed cauliflower, put in baking dish, sprinkle with grated cheese, and brown in the oven.

Creamed Celery.

Wash, scrape and cut celery stalks into inch pieces, cook until soft in boiling salted water, drain and to two cups celery add one cup white sauce. This is a good way of using the outer stalks of celery.

Scalloped Tomatoes.

In a buttered baking dish arrange alternate layers of stewed or canned tomatoes and buttered bread crumbs, having a layer of crumbs on top. Even if the crumbs are fairly stale it is well to dry them a little in the oven. Put them in a dish on the top of the stove with a little butter and stir till the crumbs and butter are well mixed. Set the dish of tomatoes and crumbs in the oven until well heated through and brown on top.

Stuffed Tomatoes.

Cut a thin slice from stem end of tomato, scoop out the pulp, sprinkle with salt. To the tomato pulp add an equal quantity of cracker crumbs and a little melted butter, chopped onion, salt and pepper. Refill tomatoes with mixture. Place in a buttered pan, sprinkle with buttered crumbs and bake twenty minutes in a hot oven.

Fried Green Tomatoes.

Slice green tomatoes, sprinkle with salt and pepper, dredge with flour or dip in beaten egg and crumbs, saute in butter until nicely browned.

Macedoine of Vegetables.

Take any of the following group of vegetables—(1), one cup diced carrots, one cup diced parsnips, one-half cup diced turnip; or (2), one and one-quarter cups carrot, one-half cup turnip, one and one-quarter cups peas; or (3), three cups split peas (cooked), three cups boiled carrot diced, one-half cup milk. Cook the vegetables separately, put all together while hot and season with butter, salt and pepper. In the third combination add the milk with butter, salt and pepper and reheat.

Boiled Dinner.

Boil a piece of corned beef, or cured ham or pork shoulder. About three-quarters of an hour before serving add sliced turnips and carrots cut in pieces suitable for serving. About fifteen minutes later add cabbage cut in pieces. It may be necessary to remove the meat so that the liquid can surround the vegetables, but the meat must be kept warm until time for serving. Serve all on the same platter.

Baked Squash, I.

Cut squash in halves, remove seeds and stringy fibres; place in dripping pan having a little water in the pan, bake in a moderate oven until soft, or from one to one and one-half hours. Scrape from shell, mash, season with butter, salt and pepper.

Baked Squash, II.

Cut squash in pieces about four inches square and peel. Place in granite baking pan and cover. Bake in a moderate oven for about one hour. Mash, season with butter, salt and pepper, or the pieces may be served as cooked, with butter, salt and pepper.

Steamed Squash.

Cut squash in pieces, remove seeds and fibres, place on cheesecloth in steamer. Cover with cheesecloth, steam until soft, or from thirty to forty minutes. Lift out, mash and season with butter, salt and pepper.

Steamed Vegetable Marrow.

Cut marrow in pieces for serving, remove skin, place on plate in steamer, cover with cheesecloth and steam until tender, about thirty minutes. Lift out, serve with butter, pepper and salt, or pour over a white sauce.

Boiled Cabbage.

Cut cabbage in quarters or eighths, soak in cold water for half an hour. Cook uncovered in a large amount of boiling salted water. If cabbage is old, change the water at the end of the first ten minutes. Drain, chop and serve with butter, salt and pepper, or with a white sauce. Or, combine with white sauce, put into a baking dish, cover with buttered crumbs, set in oven until crumbs are brown and serve as Escalloped Cabbage.

Cold Slaw (Sour Cream Dressing).

Slice cabbage and let stand for one-half hour in cold water. Mix together one cup thick sour cream and two tablespoons sugar. Remove cabbage from water, drain well. Add two tablespoons vinegar to the cream and immediately combine with the shredded cabbage.

Hot Slaw.

Slice cabbage as for cold slaw, using one-half cabbage. Make a dressing using the yolks of two eggs slightly beaten, one-fourth cup cold water, one tablespoon butter, one-fourth cup vinegar and one-half teaspoon salt. Stir over the fire until it thickens and boils. Combine with the cabbage and reheat.

Stuffed Peppers.

Take six sweet green peppers of suitable size for stuffing, two tablespoons flour, one-half teaspoon salt, two tablespoons butter, one cup rich milk, one and one-half cups cooked veal, chicken or ham, minced; one-quarter teaspoon grated onion and one-half cup buttered crumbs. Cut slice from end of peppers, remove tongue and seeds. Make a white sauce of the butter, flour, salt and milk, add meat and grated onion. Fill peppers with the mixture. Cover with buttered crumbs. Place in a baking dish, add a little hot water, and bake in a moderate oven for thirty minutes. Serve as an entree or luncheon dish.

Vegetable Soup.

Cut the following vegetables in very small pieces, having one half-cup carrot, one-half cup turnip, one-half cup celery, one and one-half cups potato and one-half onion. Mix vegetables, except potato, in four tablespoons melted butter and cook ten minutes, stirring constantly. Add potato, cover and cook two minutes. Add four cups water and boil one hour. Add one tablespoon butter, one-half tablespoon chopped parsley, salt and pepper and serve.

SALADS.

General Rules.

1. Ingredients should be thoroughly chilled.

2. Salad plants and green vegetables should be clean, crisp and dry.

3. Ingredients should be cut in attractive shapes and in suitable sizes. If too large, they are not seasoned with the dressing, and if too small, are apt to break up and become compact.

4. Add enough dressing to season well, but not enough to make the salad too moist.

5. With the exception of parsley, serve garnishes such as may be eaten with the salad.

6. As a rule a better flavour results when foods are marinated with dressing and allowed to stand at least one hour before serving.

7. When more than one food is used, marinate separately; let stand to season, then combine just before serving.

8. If an oil dressing is used, a good flavour may be obtained by marinating the salad ingredients with French dressing; let stand to season; then use boiled dressing or mayonnaise, as desired, in combining the salad. This applies particularly to cooked vegetables, meats and fish.

Salad Greens are such vegetables as lettuce, watercress, gardencress, endive chicory.

Preparation of Greens.

1. To freshen, place in cold water one to two hours, before using. If very wilted, add a few drops of vinegar to the water.

2. Wash carefully in plenty of cold water, being careful that no insects are left on the leaves.

3. Dry thoroughly by placing in or between towels and shaking gently.

4. To keep greens fresh, place in a damp cloth in refrigerator or in a covered dish in a cold place.

Garnishes.

1. Never garnish elaborately.

2. Whenever possible, use one of the ingredients of the salad in garnishing.

3. The appearance of almost all salads is improved by a careful arrangement on a bed of head lettuce or shredded leaves. Watercress and endive may also be used.

4. To make "curled celery," cut the celery stalk into small two and a half-inch strips. Slash from each end of the strip to within one-half inch of the centre. Place in cold salted water to curl.

5. To make "radish roses," cut radish into six or eight sections to within one-quarter inch of the bottom; leave stem and leaf on, place in cold water to open.

Salad Dressings.

Boiled Salad Dressing.—Mix together, dry, one teaspoon salt, one tablespoon mustard, one heaping teaspoon flour, one tablespoon sugar, a speck of cayenne pepper. Beat the yolks of three eggs and stir into the dry ingredients until smooth. Add butter the size of two eggs, two-thirds of a cup of milk and two-thirds cup of vinegar. Cook until thick. This dressing is improved by adding cream, plain or whipped, just before serving.

French Dressing.—Take one-half teaspoon salt, one-quarter teaspoon pepper, two tablespoons vinegar and four tablespoons olive oil. Combine by stirring together in a bowl, or put into a bottle and shake well.

Mayonnaise Dressing.—Mix together one teaspoon mustard, one teaspoon salt, one teaspoon powdered sugar, a few grains of cayenne, two well-beaten egg-yolks, and when well blended add one-half teaspoon of vinegar. Add one cup olive oil gradually, drop by drop, stirring constantly. As the mixture thickens, thin with vinegar or lemon juice. Add oil and vinegar or lemon juice alternately until all is used, stirring or beating constantly. A Dover egg-beater may be used. It is well to have the bowl sitting in a dish of cracked ice or ice water.

Cream Dressing, Uncooked.—Into one-half cup of sweet cream, stir three tablespoons vinegar, one-quarter teaspoon salt and a few grains of cayenne pepper. The cream may be whipped and the seasonings added.

Some Salad Combinations.

1. Lettuce and garden cress or watercress.
2. Lettuce, cress and sweet peppers.
3. Lettuce, cucumbers and parsley.
4. Waldorf apples, celery and nuts.
5. Potatoes boiled and diced, with hard-cooked eggs, parsley and red or green peppers.
6. Potatoes, mashed, with salad dressing, chopped parsley and a little grated onion beaten in while hot. Serve cold.
7. Shredded cabbage cut fine, let lie in ice water until ready to serve, drain and serve alone with dressing, or add finely minced celery, peppers, sliced tomatoes or watercress.
8. Beets boiled and diced, with chopped celery.
9. Celery with diced lean meat.
10. Chicken, celery and sweet peppers.
11. Beets and cabbage.
12. Tomatoes and cucumber.
13. Celery stalks, the hollow sides filled with cream cheese.
14. Sweet fruit salad—bananas, orange and dates; or banana, grape-fruit and orange; or grape-fruit and walnuts with sweet jelly, or pears, plums and walnuts; or apple, orange and banana.

PRODUCTION—STORING—CANNING.

Information on vegetable growing will be found in Bulletin No. 231. This bulletin contains cultural methods as well as dates for planting, standard varieties of vegetables, etc.

For information on the home canning of vegetables, readers are referred to Bulletin No. 252. This bulletin also contains information on the drying of fruits and methods of storing for winter use.

These publications can be secured by writing to the Publications Branch, Department of Agriculture, Toronto.

ADDITIONAL RECIPES

There are many variations in methods, and the space below may be used to record those which have proved successful.

Bulletin 313] [December, 1925

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

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SOIL ACIDITY AND LIMING

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S. WATERMAN, Soil Research Chemist G. N. RUHNKE, Soil Surveyor

The Foundation of *Successful* Agriculture is a Soil Plentifully Supplied with *Lime, Organic Matter* and *Phosphorus*

THIS IS TRUE FERTILITY

SOME FACTS THAT SHOULD BE KNOWN

Many of the soils of Ontario need lime.

When soils need lime they are said to be acid.

Acid soils are not productive without lime.

Lime can be supplied to soils by spreading upon them limestone, hydrated lime or marl.

The farmer should use the form of lime which will cost the least money and still do the work satisfactorily.

The Department of Chemistry, O.A.C., Guelph, knows the soil conditions in this Province and will gladly help any person to decide on the kind and amount of lime to use.

This booklet is to encourage you to use lime or limestone on your farm if you need it. It will tell you the benefits obtained from the use of lime on an acid soil.

The word lime as used in this booklet unless otherwise stated, is a general term including any kind of basic reacting agricultural lime or limestone.

Do These Pictures Mean Anything to You?

In a country which has a soil plentifully supplied with lime, abundant rainfall and progressive people, we find the best pastures, the best crops, fields of luxuriant alfalfa, comfortable homes and an air of prosperity. A prosperous farming area means flourishing towns, good markets and good times.

We do not find this kind of farm home on a soil which is acid—but suppose a soil is acid it can be brought to the same degree of fertility as shown above. Too frequently an acid soil brings about conditions shown—the following picture.

When soils need lime, crops do not do well, yields become less and less, clover refuses to grow, soil loses organic matter and produces still less. The farmer becomes discontented, no money coming in, buildings all allowed to go into bad repair, stock suffers, and he ekes out a miserable existence. There are thousands of acres like this in the Eastern United States. Do not let it occur in Ontario.

Lime Was Used Over Two Hundred Years Ago

The use of lime in agriculture is no recent practice, for we find from history that records of liming have been written as far back as 1700, over two hundred and twenty-five years ago. English records of that date mention the "prevailing practice of sinking pits for the purpose of chalking the land therefrom." Other

records claim that the only treatment a soil required in order to make it productive was good cultivation and "chalking." In 1771, one A. Young, an English experimenter, showed that 200 bushels of lime gave almost as good yield as heavy manuring. He writes of using chalk, lime and broken bones. At the same time wood ashes were extensively used, and although we know that wood ashes also contain considerable potash, still much of the benefits are derived from the lime.

At this time the soils of England had been under cultivation several centuries. Our soils have been cultivated only a little over one century, but we are realizing already the need for lime.

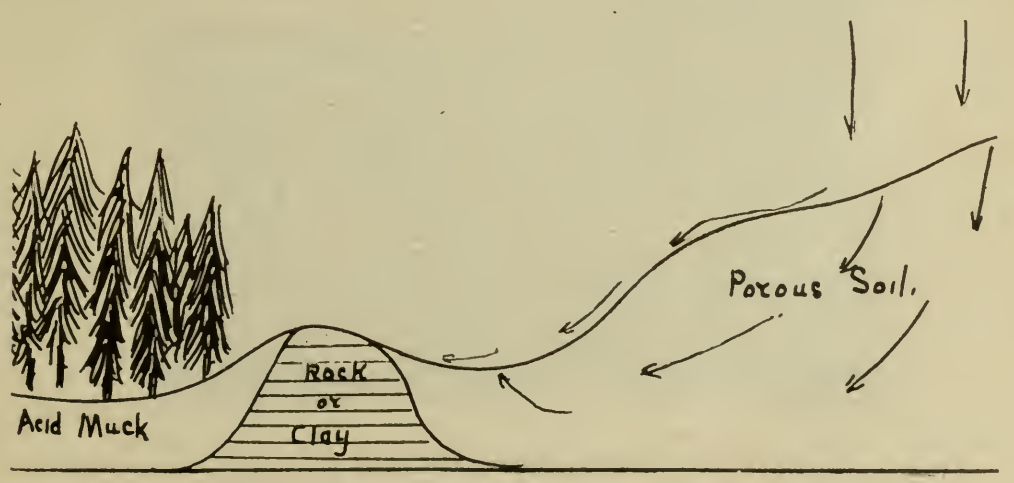
What Is Soil Acidity?

When we speak of a substance being acid we think of it having a sour taste, something that will put our teeth on edge, like the juice of a lemon, or vinegar. This is acidity. Chemists go still further and draw much finer distinctions, one of which is the effect on certain substances that we term indicators. A common one is blue litmus paper. This paper changes colour from blue to red when it comes into contact with an acid. Many substances when dissolved in water have an acid action. One of these is copper sulphate or bluestone. We know that if we dissolve it in a tin or iron pail it will "eat" it. This is due to acid formed on dissolving. There are many compounds in a soil which have the same property—not copper compounds but compounds of silica, aluminium and iron. For example if we heat ordinary sand in steam under pressure it becomes an acid, silicic acid, which has the properties common to all acids.

So often we hear the expression "sour" in speaking of soils. It is generally used to describe a soil which is poorly drained, more or less waterlogged and in poor physical condition. It may be acid or it may not, and therefore the term is misleading. There is only one term we can correctly use and that is "acid." If a soil behaves under chemical investigation in a certain way it is acid. If it has plenty of carbonates or lime present it is not acid. So we will drop the term "sour" completely in speaking of soils.

How Soils Become Acid

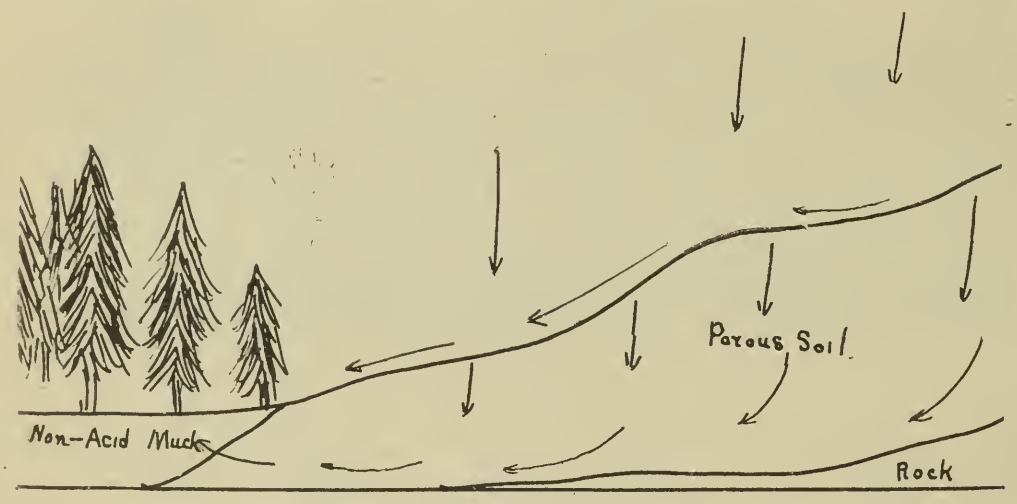
The acidity of soils is, therefore, due to acid salts, those that have an acid action when in solution, or to free acids. These acids and acid salts may result from decomposition of organic matter or from changes which occur gradually



due to leaching or washing away of bases from the soil. Thus we have two types of acidity which may occur singly—and they generally do—or may occur together.

Acidity due to decaying organic matter is largely found in peaty soils which are not affected by washings from surrounding high land. We find this condition of affairs in Northern Ontario muskegs, where the subsoils which normally might contain lime are buried deeply under a soil composed entirely of decayed plant matter. The first diagram gives an idea how this might occur. The protecting ridge prevents surface water and underground water carrying lime in solution from entering the peaty soil and neutralizing the acid present.

In the next diagram there is nothing to prevent the lime-charged water from higher land from flowing across the gentle slope to the muck area. As fast as



the lime is carried into the muck it neutralizes or destroys the acidity present and prevents any harmful action. All muck soils are not acid. Far from it! many have more lime than the uplands.

High Land Tends to Become Acid First

This idea is new or comparatively so and contrary to the belief of many. It has been generally understood that low lying land is generally acid but now

Knolls become acid first and alfalfa kills out.

the opposite has been proven. Let us see how this is. In a climate like ours we get about thirty inches of rainfall in a year. As this rain falls on the soil it

soaks in. In passing through the air it dissolves carbon dioxide which is always present and forms a very very weak acid. So weak is this acid that we cannot detect it except by very delicate tests. This acid dissolves the lime out of the soil, and although it is very slow in action, within a hundred years it dissolves out a great deal. "Many strokes will fell great oaks!" and though the solution of lime is very very slow we can readily understand how after a hundred years a great deal of lime will be removed. How do we know lime is dissolved? Look at the inside of the tea kettle and ask yourself how this lime got there. Plainly from the water. The water comes from the well or spring so that the rain water must have dissolved the lime in passing through the soil.

We can readily understand how higher areas are more subjected to washing and leaching than more level lands. Don't forget this—all lands will become acid in time and it is only a question of time! but the higher portions will be first affected because the lime removed from them will largely be carried to the lower levels.

Lime Concentrates in Lower Soil Layers

Let us now look at the case of a more or less level field. The same dissolving action takes place in the soil, and the water percolates downward carrying the lime in solution with it. It then passes out of the soil by tile drains or natural

Field of Corn
In an acre of good corn there are about 25 lbs. lime.

Field of Oats
In an acre of good oats there are about 20 lbs lime.

channels or remains in the soil, gradually being removed by evaporation. The fact has been established, however, that the capillary water rising to the surface to replace that lost by evaporation does not restore the lime removed on its downward movement. So we see that there is a tendency to concentrate the lime in the lower layers of the soil, while the soil at the surface may become distinctly acid.

Another fact bearing on this particular phase is that the water by the time it reaches the subsoil is satisfied with respect to its solvent power and has no further effect. Therefore, the lime in the lower layers of a soil is little affected and remains unchanged for perhaps centuries. At the same time the acid layer is deepening and we must, therefore, supply the lime deficiency before it becomes serious.

The following table gives an idea of the total lime content of several soils at different depths.

Lab. No.	Soil Type	Per Cent. Lime (CaO) Surface	Subsurface	Subsoil
29	*Lockport clay loam	.368	1.324	1.85
124	Lockport clay loam	.477	1.688	4.24
82	Clyde sandy loam	2.46	6.06	9.01

Continual cropping also removes lime in considerable quantities. Every bushel of grain you sell, every forkful of hay you handle has taken lime out of the soil. A load of alfalfa will remove 100 pounds of lime and a ton of red clover about 75 pounds. In an acre of good corn there are about 25 pounds of lime and in an acre of good oats 20 pounds.

Many other things sold reduce the lime in the soil too. In every ton of milk there are sold 60 pounds of lime. The whole bony framework of all animals sold consists largely of lime. The skeleton of a 1,000-pound cow sold takes 130 pounds of lime off your farm.

In a 1,400-pound horse you sell 182 pounds of lime, and in a 200-pound hog 26 pounds of lime.

Now add all these losses together and you can see how lime becomes less and less and less and finally there isn't enough left to neutralize the acids in the soil and the soil becomes acid. And an acid soil is a sick soil. When we become sick we get medicine, but in many cases we let the soil get worse and worse till it quits altogether and refuses to raise any more crops.

Effects of Soil Acidity or Lack of Lime

We see now that these two terms mean the same thing, for when lime is lacking the soil becomes acid.

One of the first symptoms of soil acidity is the failure to secure a catch of clover. Of course this may be due also to lack of inoculation, but if, having inoculated the clover seed, we do not get a stand of clover we begin to wonder if the soil is not acid. Now clovers are plants which are heavy feeders on lime, so heavy that if lime is lacking they fail to do well. A ton of alfalfa contains nearly 100 pounds of lime. A ton of wheat grain contains only about three pounds of lime. So you can see that the alfalfa must have a very plentiful supply. Other crops such as sweet clover, red clover, cabbage, spinach, peas, beans, sugar beets and tobacco are also heavy feeders on lime. Other crops require it too, but not as much. Lack of lime then means that plants suffer from lime starvation.

It is not a question of the lack of lime alone either. The acid soil affects the cell sap—the blood of plants. Each plant has a certain degree of acidity in its sap and if this is disturbed—made more acid—it causes the plant to suffer—to become ill. The acid condition of the soil also allows compounds of aluminium, manganese and iron to dissolve and these are absorbed by plants and poison them. Under proper conditions where no acidity is present these substances are insoluble and cannot do any harm. We know that soluble aluminium compounds are responsible for root rot of corn and are toxic to barley. While plants cannot live without some iron a large amount of soluble iron is very bad for them.

We all recognize the value of alfalfa as feed. We also know that sweet clover is possibly the best soil builder we have. Neither of these crops will grow strongly

*For description of these soil types see Bul. 298.

on an acid soil. Further, while they generally secure their nitrogen supply from the air they are helpless in an acid soil and become the same as a cereal crop depending on the soil itself for their nitrogen—if they grow at all. So if the soil is acid we can see the results plainly. Let us put them down in order: (It is well to remember that a deep rooted crop can secure lime from the lower layers, and is more or less independent of surface soil conditions.)

1. Plants have difficulty in securing enough calcium to produce the best growth.
2. Plants cannot secure the other plant food they require to the best advantage.
3. Acidity liberates mineral salts in the soil which are toxic to plants.
4. Bacterial action making use of atmospheric nitrogen is prevented, compelling us to purchase the nitrogen required.
5. Nitrification is retarded.
6. The amount of calcium in the resulting crop is lessened and therefore animals fed on such fodder lack the mineral elements in their food, and do not thrive as well as they would were they receiving enough minerals.

HOW WE CAN TELL IF THE SOIL NEEDS LIME

Simple Tests for Acidity

There are several simple tests for acidity which any farmer can carry out on his own soil, but one which never fails is to try lime on a plot on the farm. If

Showing Test for Lime with Acid.

no effect is noticed on clovers, you do not need lime and have no acidity or not enough to do any harm.

Sometimes we can tell if a soil is acid by the vegetation that grows on it. Where clovers and other legumes do not do well, and moss, sourdock and sheep sorrel flourish, it generally indicates that the soil is acid.

A very simple test is by the use of hydrochloric acid. Your druggist will call it muriatic acid, and you can get it at any drug store. At the same time get some blue litmus paper.

Pour a small quantity of the acid on a sample of soil and watch for bubbles. If the soil bubbles or effervesces it shows there is lime present. Try it first on a

piece of limestone or some air-slaked lime to see how it acts. Remember, the muriatic acid is poison and should be labelled plainly and put away out of reach of children. Placed on the skin it causes severe burns, which take a long time to heal. A glass-stoppered bottle such as an old perfume bottle makes the best container, as it eats ordinary cork stoppers. Or this test may be made by moulding a ball of soil and pouring a little of the acid in a crevice or depression.

If you have no effervescence on the addition of acid, you may have acidity or you may not. At any rate you haven't much lime to spare. Now try the litmus paper, as shown below.

Make a ball of moist soil. Break the ball open and enclose blue litmus paper. Close ball on litmus and let remain ten minutes.

If the blue litmus paper changes to red we infer that the soil is acid. The next question is "How acid is it?" It isn't advisable for an inexperienced man to make any further investigation because it is a question if he can do it accurately enough. The next step is to take a sample or several samples of the soil from that field and send it to the Department of Chemistry, O.A.C., Guelph. Here it will be correctly analyzed and a report given as to the amount of lime to apply in order to correct acidity present, and a little to spare. A four-pound sample of

Department of Chemistry, O.A.C., where your soil is examined.

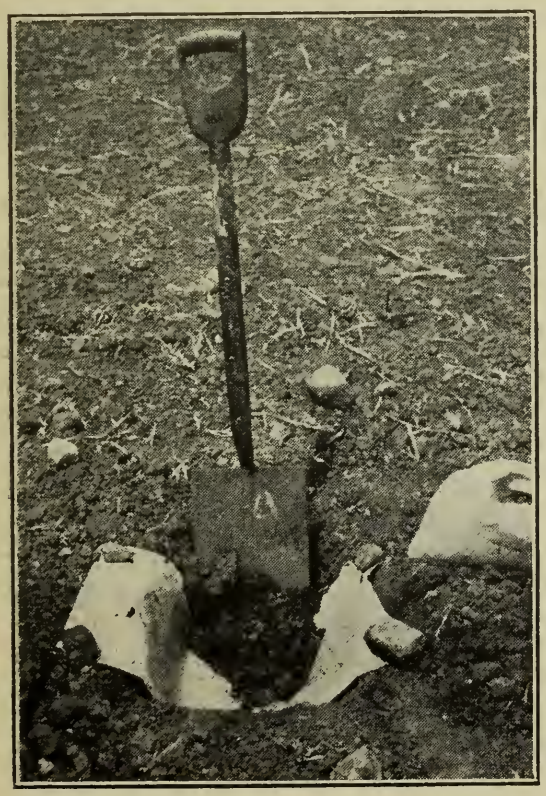
soil is enough, but it must represent the field. If the field is fairly level a sample taken a dozen places and well mixed will be satisfactory. If the field has high and low land sample each separately, and if there are knolls send a sample from their tops. Don't think one sample from a farm is enough. Every field may be different, and even parts of the same field may differ.

How to Take Soil Sample

If a man builds a barn he makes certain he has a firm foundation. No matter how good a job the carpenter makes of the frame, unless the foundation is solid his work is of no value, for in time the whole building will fall.

The same is true of taking a soil sample. If the sample be not properly taken all the investigational work on that sample is wasted, meaning a loss of time and money for work and materials. So if any chemical investigation is to be carried out on a soil sample, the foundation must be the proper taking of that sample.

Proceed then in this way. Go over your field carefully and decide where you will take samples. Then take a clean spade (one coated with rust will not do) and cut a hole with a sloping side. Place a sheet of newspaper in the bottom



Taking a soil sample with spade.

Taking a soil sample with an auger.

of the hole and cut a slice about one inch thick, throwing it over on the paper. Gather the sample and place it in a pail or clean bag. Take all the other samples the same and if there are no great variations in the field, mix all the samples together on a table. Then divide the heap in half. Discard one-half and heap the other up. Divide it again, discarding part, and redividing until a portion of about four pounds is obtained. Mail it in a cardboard box, or clean tin container to the above address.

At the same time send a similar sample of the subsoil from one foot to two feet deep. In many cases the character of the subsoil has a great influence.

Another very good method of taking a sample is to use an auger. An old auger from three-quarter inch to one and one-half inches makes an excellent soil auger. File the thread tip off flush with the cutting blade, and get the blacksmith to make a two-foot extension to lengthen it to about forty inches. To take a sample simply bore into the soil, pulling the auger straight up, and

remove the adhering soil. The great advantage of the auger is that samples can be obtained to a great depth with little labour.

In taking samples *keep in mind* that the sample, unless *properly* taken, means *waste of time* and possibly *incorrect advice* to you, as we at the Department of Chemistry advise you *according to the sample sent in.*

At the time of taking the sample answer the following questions:

1. What is the nature of the subsoil?
2. Is there good natural or artificial drainage?
3. What was the previous cropping (last four years)?
4. What crop do you wish to grow on this soil?
5. When was it manured last? How many loads per acre?
6. Have artificial fertilizers been used?
7. Has lime been applied?
8. Does this land receive surface wash from higher land?
9. Do sheep sorrel, horsetail and such acid-resistant plants as mentioned later in this bulletin grow on this soil?

Write your name and address on the outside of the parcel so we can identify it when it comes in.

BENEFITS FROM LIMING

Take another look at the photographs on page 2. We do not say that by just liming your farm it will develop into a prosperous homestead. Not at all; there will be a few years of hard work, skilful planning and a great deal of thinking to do before one arrives at that stage. But lime does do this: It enables you to grow legumes to the fullest extent. It increases your crops by liberating plant food from the soil, mainly potash and indirectly nitrogen. It stimulates bacterial activity in the soil which results in greater crop growth. With clovers to plough under to enrich the soil in organic matter, increased yields of all crops grown, thrifty livestock and work, no one can help progressing, and the result is seen in the prosperous appearance of the farm. Generally speaking the soil high in lime is very productive.

The principal result from liming is largely indirect. While it does actually supply plant food to crops its main function is to bring about those conditions in a soil which favour bacterial activity, and thereby increase the supply of available plant food in the soil.

Lime is Not a Fertilizer

One of the first facts that a man should have firmly fixed in his mind is that lime *is not a fertilizer.* A fertilizer, "according to the Fertilizer Act, includes every processed manure containing nitrogen or phosphoric acid or potash."[1]

Lime contains only minute percentages of these constituents and therefore cannot possibly be classed as a fertilizer. A short time ago the writer was approached by a farmer who informed him that "Lime is no good. I put it on potatoes last year and my money was wasted. They didn't do as well as where I put manure." Questioned, this man stated that he manured a part and put lime on the rest and was disappointed because the manured part was better. In the first place he did not know whether his soil needed lime or not; secondly, he used it on a crop which seldom shows any response to liming. It is no wonder no results were seen. Further, he regarded lime as a fertilizer, which is altogether wrong. This brings out another point.

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[1] Quotation from Fertilizer Act. Dominion of Canada.

Some Plants Grow Better in an Acid Soil than Others

Nature seems to have adapted some plants so that they can live under conditions that other plants cannot tolerate. Watermelons, blackberries, strawberries, hydrangeas, azaleas, ginseng, rhododendrons and some other plants grow very satisfactorily in an acid soil, providing it is otherwise fertile. Potatoes are sometimes said to grow better in an acid soil. This opinion is based on the fact that lime in the soil encourages the growth of scab, which harms the potatoes. Lime really makes the soil better for potatoes when there is no scab, although the benefit is never very marked. Better lime the soil after the potato crop than before it. Some grasses are quite highly acid resistant. Redtop, tall meadow oat grass and bent grasses are very high in the list. Timothy can withstand quite a lot, so that in many soils where clovers will no longer grow timothy does well.

The weeds previously mentioned as growing in acid soils, grow there because they meet less competition from useful plants. If the soil be limed they will soon be crowded out by the clovers. So lime is really a weed fighter. In a good stand of clover weeds have little chance.

Do Not Expect Full Returns from Lime the First Year

This has been a serious drawback to the more general use of lime in this Province. Many men whose soil required lime used it and seeded with oats, wheat, rye or other crops upon which the effect of lime is not marked. In many cases no effect was noted, and the user was disappointed. It is very likely that in many cases these men had the idea of a fertilizer in mind, and expected to see things jump, and were disappointed. If you will look at the list of crops on another page you will understand why we do not expect results on grain generally. If lime is applied to grain seeded with clover we probably will see no result until the second year.

Does Lime Decrease Organic Matter Content of Soil?

There is an old saying that

> "Lime and lime without manure
> Will make both farm and farmer poor."

We know that caustic lime (quicklime and hydrated lime) is a powerful agent in hastening the destruction of organic matter. For ages the custom of scattering lime over material, of which the decay was required, has been practised, and until recently the idea that lime hastens the removal of organic matter from soil has been put forth by many soil investigators.

At present the effect of different forms of lime on organic matter is a disputed question. There are indications that a change of opinion is gradually being brought about, evidenced in a report recently issued by Pennsylvania Experimental Station (August, 1924). Since this is the oldest lime experiment in America (forty years) we are reasonably safe in accepting the conclusions as drawn. They concluded "that there is no significant difference in the action of burned lime and limestone on soil organic matter at the end of forty years of continuous treatment during which the two forms of lime have been applied in amounts eight times that now recommended for a soil of limestone origin."

We recognize the fact that caustic lime is more rapid in its action but we must also remember that the period of activity is shorter than that of the lime-

stone. So it is reasonable that the action over a long period of time would be very similar in both cases.

It is reasonable to assume that, with increased nitrogen fixation and increased crop production, more crop residues would be returned to the soil, and where lime is plentiful the result will be evidenced by increasing organic matter and nitrogen content.

Forms of Lime

So far, we have used the word lime as a general term to include any form of lime which can be used for agricultural purposes. We will now examine each form separately.

Ground Limestone is simply limestone rock finely ground. Generally it is a by-product of quarries making road material—the finer screenings which are of no value for building roads. Occasionally chippings from quarries producing building stone are sold under this head as well.

1,480 lbs. slaked lime or 1,120 lbs. quick lime or 2,000 lbs. limestone will do the same work in the soil.

Quicklime is burned lime—limestone which has been heated so as to drive off the carbon dioxide, leaving the oxide of calcium according to the reaction

$CaCO_3$ heated—$CaO + CO_2$

Limestone—Quicklime + Carbon dioxide.

Hydrated Lime is quicklime which has had enough water added to it to change it into calcium hydrate and still leave a dry product.

$CaO + H_2O$—$Ca(OH)_2$

Quicklime + Water—Slaked Lime.

It is ordinarily known as slaked lime and may be purchased from any dealer in builders' supplies.

Air Slaked Lime is quicklime which has been exposed to the air for some time. It absorbs moisture and carbon dioxide from the air, and slowly changes into a mixture of the hydrate and carbonate.

Gypsum or Calcium sulphate is found in beds, or deposits in various parts of the Dominion. Pulverized it is commonly known as land plaster and in past years was used very extensively. It is useless for the purpose of neutralizing acidity in the soils, but of the same value as ground limestone for all other agricultural purposes.

Marl is found in deposits in different parts of the Province. It consists mainly of calcium carbonate but occasionally is mixed with sand, organic matter

and clay. It is not sold for agricultural purposes to any great extent. It really is a form of soft limestone that has settled in low places and beds of streams. It may be in almost a powder or in lumps mixed with small rocks and shells. When wet it often looks like blue clay. Don't mistake blue clay for marl. Try it with hydrochloric acid. (Marl effervesces. Blue clay will not.)

Lime Refuse is a product from the lime kilns and consists of unburned limestone, quicklime, air slaked lime and sometimes wood or coal ashes, sand and clay. It is quite satisfactory for use as agricultural lime.

Gas Lime is a by-product in the purification of illuminating gas. It contains certain sulphides of lime which will destroy vegetation and hence the immediate application to the soil is not advised. But if it is put out in small heaps or spread out in such a way that the air can get through it these harmful sulphides will in time be changed into sulphates. It is then a mixture of calcium carbonate and gypsum and may be used safely where either one of these is desired.

Acetylene Residues. Where acetylene is used for lighting the residue from the generator is quite safe to use, providing it is left exposed to the air awhile before applying. Chemically it has the same composition as slaked lime and acts in a similar manner.

Wood Ashes, unleached, contain about 5 per cent. potash and 25 per cent. lime. Leached ashes have very little potash. While wood ashes are valuable and should always be placed on the land, they are not a good buy unless you need potash and lime.

Basic Slag is a by-product of the manufacture of iron. It contains about 50 per cent. lime and 12 per cent. P_2O_5 and is sold for its phosphorus content. While it undoubtedly neutralizes considerable acidity in the soil it is too expensive for this purpose alone.

Other sources of waste lime are beet sugar factories, tanneries and paper mills. Often this lime is wet, heavy and hard to handle. Where it can be obtained and spread cheaply, and the haul is short, it could be used on the soil. If there is a supply near consult the Department of Chemistry, O.A.C., Guelph, before you use it.

Calcium or Magnesian Limestone, Which?

Some time ago considerable unrest occurred among farmers purchasing limestone on account of the statement that dolomite or limestone containing magnesium was detrimental to crop production. While it is regretted that no experiments have been carried on in this Province to obtain local results on this question we are perfectly safe in accepting the results obtained all over the United States. In the majority of the states they are using crushed dolomite, and in some cases have been using for many years with no ill effects. A great part of the soil of Ontario is underlain with dolomite, and the limestone scattered through it is dolomite. This soil has been worked for upwards of a century, and no ill effects have been noticed. The Department of Chemistry, O.A.C., during the past five years has laid down experiments widely spread over entire Western Ontario with this type of limestone. If magnesian limestone were detrimental we would naturally think that crops grown at Guelph, where the limestone is all dolomite would be inferior to those grown in the vicinity of Beachville, where the rock is pure calcium carbonate. We do not find this so.

We do know this, however: that quicklime or slaked lime made from rock containing a high percentage of magnesium does not produce as quick-setting

mortar as that made from calcium carbonate. Setting of mortar is simply changing, by natural means, from the hydrate to the carbonate due to absorption of carbon dioxide from the air, with the liberation of water.

$$Ca(OH)_2 + CO_2 — CaCO_3 + H_2O$$

Slaked lime + Carbon dioxide = Calcium carbonate or limestone, water.

Magnesium hydrate does not absorb carbon dioxide as readily as calcium hydrate and hence tends to preserve an alkaline or caustic action in the soil, which may be detrimental to plants. This is what happens when a heavy application of slaked or quicklime, containing a large percentage of magnesium, is applied to soils. This cannot possibly happen when the carbonate form is applied as crushed limestone, and we, therefore, make no distinction between calcite or calcium limestone, and the mixture of calcium and magnesium carbonate, which is dolomite or magnesian limestone.

Which Form of Lime Shall We Use?

Of all the materials cited, there are only three which we can secure generally throughout the Province. These are crushed limestone, quicklime and slaked lime.

Of the three we unhesitatingly recommend crushed limestone for general agricultural purposes. It is cheap, effective, more pleasant to handle than the others and in general just as effective, with absolutely no danger of overdoing the job. No distinction is made between calcium carbonate or calcite and dolomite.

Quicklime or freshly burned lime may be used, but cannot be recommended unless slaked before using, when of course it becomes slaked lime. In general quicklime is not used except when obtained cheaply, in an impure form, from limekilns.

Slaked lime has been used extensively and has made a name for itself. It is much more expensive than the crushed limestone, but is quick in action and very satisfactory except on light soils. It is rather unpleasant to handle also.

We must note here that quicklime and slaked lime, weight for weight, are more effective as neutralizers of acid than crushed limestone in the proportion of 56 : 74 : 100.

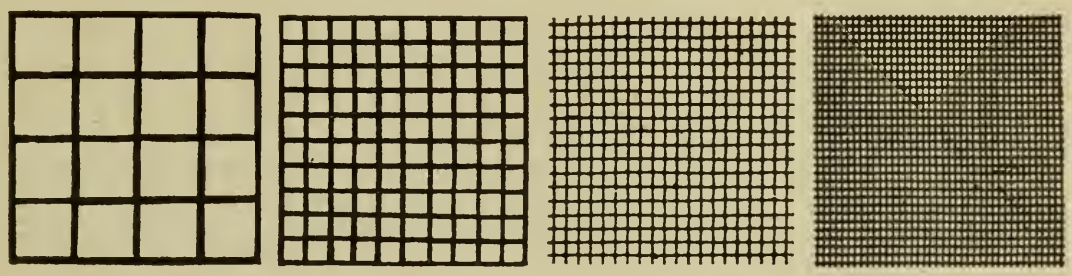
We see then that 2,240 pounds of quicklime will do the work of two tons of crushed limestone. Where a long shipment is made this would mean a considerable saving in freight, but generally this advantage is counterbalanced by the increased original cost of the product.

How Fine Should Limestone Be Ground?

The finer limestone is ground the quicker its action in the soil, but it is not necessary to have it as fine as flour. The screens commonly used to determine fineness may be designated as follows: A quarter-inch screen, or 4-mesh screen, has 16 openings to the square inch; a 10-mesh screen, 100 openings; 20 mesh, 400 openings, and a 40-mesh, 1,600 openings to the square inch.

Experiments have shown that limestone passing a quarter-inch screen gives excellent results if used liberally. When it all passes the ten-mesh screen, a great deal—possibly 50 per cent.—will pass a 40-mesh screen, and some a 100-mesh. If much grinding is done it means that the product must be sold at a higher figure, for some one has to pay for the cost of grinding and generally it is the consumer.

The Department of Chemistry, O.A.C., recommends a degree of fineness so that it all passes a ten-mesh screen, 50 per cent. of it a 40-mesh and 30 per cent. 100-mesh. The finer particles are effective soon after application, and the



Quarter - mesh screen means four meshes or wires to the inch.

Ten-mesh screen means ten meshes or wires to the inch.

Twenty - mesh screen means twenty meshes or wires to the inch.

Forty-mesh screen meansforty meshes or wires to the inch.

coarser are in reserve for future action. Finer grinding is considered unnecessary, and it is reflected in an increased selling price.

SUMMARY

Forms of Lime

Ground Limestone. 100 per cent. 10 mesh, 50 per cent. 40 mesh, 30 per cent. 100 mesh. Best and cheapest form to use. The natural way—always the best. Don't worry over dolomitic or magnesian limestone.

Quicklime. Too caustic in action and expensive. Out of the question for general agriculture.

Hydrated Lime. More expensive than crushed limestone. Useful where quick action is wanted or on small areas. Desirable on heavy soils owing to its beneficial action on the physical condition of the soil.

Air Slaked Lime. No great supply. Can be dropped from discussion. All right if you can buy it cheaply.

Gypsum. No good for acid soil—only makes it worse. Useful as an indirect fertilizer.

Marl. Good to use if you can get it easily. Not marketed.

Residue from Acetylene Generators. Perfectly safe to use after weathered.

Lime Kiln Refuse. Same as for marl.

Gas Lime. Requires careful handling to be safe. Read description again.

Wood Ashes. Fine if you need lime and potash, and can buy cheaply enough.

Basic Slag. Contains lime, but is a phosphatic fertilizer. Do not buy it for the lime it contains, although that is a consideration.

How Much Should Be Applied?

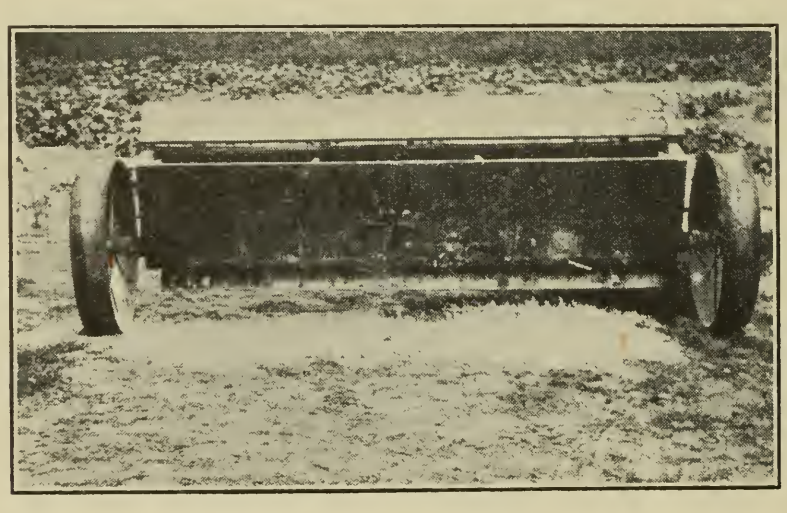
Under general conditions, if you find your soil is acid enough to turn blue litmus paper red in fifteen minutes, you should apply at least two tons of crushed limestone, or equivalent quantity of slaked lime per acre, and repeat at the end

of four years. To be certain, and it is always preferable to eliminate guesswork, send your soil to the Department of Chemistry, O.A.C., where it will be analyzed and you will be told how much it requires. Play safe always.

When to Apply Lime

The best answer to this is "When you have the time." Lime is not for the benefit of any particular crop, but for the benefit of all the crops of the rotation. The best time possibly is to apply just before the crop with which you seed your clovers, or before peas. A very good time to apply it is just after harvest, before seeding with fall wheat. The roads are good then, and it can be spread quite satisfactorily.

In some localities farmers combine and build a lime shed at the station. Lime is unloaded into it and is hauled home at leisure. There is a good chance for your local co-operative association to do this if you need lime in your district.



Showing how lime is distributed by a lime-spreader.

Hydrated lime should be spread on ploughed ground before working up. If applied in fall or winter considerable may be lost by washing off. Ground limestone can be spread on growing crops, such as wheat, clover, alfalfa, etc., without damage to the crop if spread when the crop is small and ground solid. It is much better to put it on before the crop is planted, however. Caustic lime may do harm if a heavy application is put directly on the plants.

Lime has been applied in winter, but it is unsatisfactory. It may be hauled home in winter, stored till the ground is solid and then put on. This is a point one must think out for himself.

How to Spread Limestone

The main point is to get material evenly distributed over the ground. This is best accomplished by means of a limespreader.

The choice of a limespreader is quite important. They are made by several of the firms manufacturing agricultural implements and prices may be had from your local agent. The spreader should be strongly made and designed so that the lime will not "bridge" over the feeders and refuse to run. Even spreading

and good service are the two essentials. Any form of lime will work satisfactorily in a good machine. If the cost of a lime spreader seems too great for any individual, it may be bought co-operatively if the soil in the locality requires lime. When lime is bought it must be unloaded within a day of the time it arrives in order to avoid demurrage. It is not always possible to spread lime the day it is hauled to the farm, but it can be piled along the field where it can be loaded right into the spreader.

It will often pay when hauling limestone to hitch on an extra team and haul part of it to the middle of the field so that the spreader can be filled without driving back empty. It has to be hauled to the centre of a long field anyway, and is more cheaply and easily done while on the wagon.

If the farm is close to the station time can be saved by using three wagons and two teams. One man stays at the car loading the wagons. One man and a team haul the loaded wagons from the car to the field, and the other man and team keep the lime spreader going. A load is hauled to the field, unhitched from and left to be spread, while the team takes the empty wagon back to the car to be loaded. This plan will not work if the field is too wet to spread the limestone when it is unloaded, and if the haul is a long one, more men and teams will be required. This difficulty is solved by

A Lime Storage Bin

This would take the uncertainty out of spreading limestone as it is hauled. The lime can be dumped in the bin from the car and left there to be hauled home at leisure. If a load of grain is hauled to the station a load of lime can be brought home, and thus save much time. A lot of time is lost driving to and from the station with an empty wagon. It is not efficient.

What Will Lime Cost?

Naturally before we purchase lime we must figure on the cost. We must remember that producing and shipping lime costs money and, therefore, we must expect to pay for it. If we were in the business we would naturally wish to make it pay. Of course, we want to buy our lime as economically as possible, but if the soil is so acid that clovers will not grow, it is cheap at any price.

If you have to buy lime, providing it is of suitable degree of fineness, buy from the cheapest source. The people handling lime for agricultural purposes all advertise. Write to them and get their prices and buy where you can most cheaply. Of course you will have to figure on freight rates, which may be secured from your agent, or the firms may quote you prices F.O.B. your station. The cost of application depends on how far you are from the station and how you apply the lime. It is for you to handle it most economically.

Do not pay any attention to the claims of one product being so much better than the others if the degree of fineness is the same. It would be well to remember that when buying slaked lime you only pay freight on 1,480 pounds whereas the equivalent quantity of crushed limestone will be 2,000 pounds.

As a general rule the increased cost of the hydrate overcomes the slight advantage in less freight charges.

If the Soil is Acid Lime Should be Used at Once

Many objections are taken to the practice of liming. These are mainly due to the fact that some men have regarded lime as a fertilizer, and expected an increased return no matter for what crop the lime was used. This is not true. Some crops respond more quickly than others because they differ in their feeding requirements and powers. *The purpose of lime is to neutralize acidity if present: if not, don't use it. If your soil is acid use it at once in proper quantities.*

Lime Not Necessary for Apple Orchards

From work done during the past twenty-five years, we conclude that lime is of no direct value to apple trees. The nature of the root system of the apple, penetrating fairly deeply into the soil, enables the tree to obtain all the lime it requires from the subsoil. The apple, furthermore, is a plant which prefers a slightly acid soil and does best under those conditions. However, lime is of indirect value because it enables us to grow leguminous cover crops in the orchard and thereby supply organic matter and nitrogen which are the two constituents absolutely essential for maximum production of fruit.

Lime in Relation to Other Crops

Cereals as a general rule are not responsive to lime except possibly barley, which will show results. They have a type of root system which enables them to secure their requirements of lime even if it is very scarce. Barley is distinctively a surface feeder and if lime is at all deficient, that deficiency will be most noticeable at the surface. The growth of legumes becomes more and more unsatisfactory as lime decreases. With a small quantity of lime they grow in a half-hearted fashion. If they can persist until the root gets down into the lime bearing subsoil they will grow luxuriantly. This is noticed in many cases with alfalfa and sweet clover. The first year the plants do not do well, but the second year, and after, they come along splendidly. This is due largely to the fact that lime is deficient in the surface and the young plant has a tough time for the first year to get established. Later it comes all right when the roots get down into the lime area. Peas, beans and soybeans are also dependent on the presence of lime. All legumes depend for their nitrogen on the assistance of the bacteria found in nodules on their roots. Lime enables these bacteria to work, so lime is necessary and in quantities sufficient to neutralize all acidity of the soil.

Other crops need not be dealt with fully, except to say that if they are classified on the following page as lime-loving they will be benefited by the application of lime. If classified as acid resistant, the effect of liming will not be noticeable.

Mention has been made as to the amount of lime various crops contain and to their response to the application of lime on an acid soil.

The following table gives the percentage of lime (CaO) the feeding power of the plant for lime, and the rate of response to the application of lime.

	Per Cent. Lime, Dry Basis.	Feeding Power of Plant for Lime.	Response of Plant to Liming.
Legumes			
Alfalfa	3.00	2	5
Sweet Clover	1.94	3½	4
Clover, Red	2.40	3½	3½
Clover, Alsike	1.62	2½	2½
Clover, Crimson	1.92	4	2
Clover, White	2.21	4	2
Beans (Vines)	1.32	4	2
Cowpea (Hay)	2.70	5	2
Peas (Vines)	3.12	2½	4
Soybean (Hay)	2.76	4	3
Vetch (Green)	1.96	4	2½
Non Legumes			
Barley	.95	3	3½
Buckwheat	3.33	5	2
Corn	.83	3½	2½
Oats	.53	4	1½
Rye	.51	4	1
Wheat (Winter)	.48	2½	2
Hay and Pasture Grasses			
Italian Ryegrass	1.07	4	2
Kentucky Blue grass	.42	2½	2½
Meadow Fescue	.57	3½	2
Millet	.46	3½	2
Orchard Grass	.46	3½	2½
Perennial Rye Grass	.64	3½	2
Redtop	.57	3½	1
Timothy	.71	3½	2½
Miscellaneous			
Potato (Vines)	2.80	3	2½
Rape	1.78	3	3½
Sugarbeet (Leaves)	3.00	2	5
Sorghum	.26	4	2
Tobacco	3.40	2	4
Turnip (Leaves)	3.83	2½	3
Cabbage (Leaves)	5.93	2½	4
Carrot (Leaves)	4.45	2	3½
Cauliflower	2.04	1	4
Cranberry (Leaves)	.40	3	1
Celery Shoots	1.88	1	5
Grape (Leaves)	2.55	3	3
Lettuce	2.65	2½	5
Onion (Leaves)	3.53	1½	5
Rhubarb (Leaves)	.32	3	2½
Radish (Leaves)	4.30	3	3
Spinach Top	1.96	2	5
Strawberry (Vines)	1.22	3½	2

Another Classification of Crops

Lime Loving

These need lots of lime to grow well.

Alfalfa	Sweet Clover	Red Clover	Peas
Soybeans	Barley	Rape	Sugar Beets
Tobacco	Turnips	Cabbage	Carrot
Cauliflower	Celery	Grapes	Lettuce
Onions	Radish	Spinach	

Acid Resistant

These do fairly well on an acid soil, but will not be harmed by an application of lime.

Alsike	Clover, Crimson	Clover, White	Beans
Cowpeas	Vetch	Buckwheat	Corn
Oats	Rye	Wheat (Winter)	Italian Ryegrass
Kentucky Bluegrass	Meadow Fescue	Millet	Orchard Grass
Perennial Ryegrass	Red Top	Timothy	Potato
Sorghum	Cranberry	Rhubarb	Strawberry

In explanation of the tables we find alfalfa with 3 per cent. CaO, cabbage 5.93 per cent. and sugar beet leaves 3 per cent. On the other hand oats, rye and the grasses contain only about one-half of one per cent. of lime. Alfalfa, sugar beets and cabbage have a low feeding power, so it is natural to assume that their response to lime will be great. This is given in the table as 5. Oats and the grasses have a high feeding power and require little so they can secure their requirements even when the supply is limited. We do not expect any result then

on these crops, which can be predicted from the table, where the response of oats is expressed as 1. Since alfalfa is (5) we expect five times the result from lime on alfalfa as on oats.

No crops are harmed by lime, but you need expect no results on the crops stated in list as acid resistant. For the lime-loving crops, lime is necessary.

LIME MAKES MANURE AND FERTILIZER WORTH MORE

Manure is the best fertilizer we can get, but manure alone will not bring full returns on an acid soil. When the soil is acid the plants cannot obtain the food from manure that they could if there were lime present. There is very little bacterial activity going on, hence the manure is not decayed as readily and its plant food is not liberated so that the plant can obtain it. We know that ammonification, that is, the breaking down of complex nitrogen compounds in the manure into ammonia compounds, proceeds as well if lime be not present, but this is of little value, because the plant cannot make use of ammonia compounds to any great extent. What is wanted is the action of the bacteria which form nitrates, and they can work only where lime is present, and, therefore, where no acid exists. Thus lime ensures the full effect of manure.

As regards fertilizers, lime affects the nitrogen and phosphorus carriers most. Any organic nitrogen compound such as in bone meal, blood meal and tankage have to be converted into nitrates before they are available for plants. This is done by bacteria in the same way as in manure. Therefore, lime hastens this action and makes these nitrogen fertilizers more effective.

THE RELATION OF LIME TO NITROGEN

Nitrogen we know is the most important element in crop production, if we can say that one is more important than another. Its importance is due to two things. It is the element that produces stem and leaf growth in crops, giving a lusty plant, and is the element most easily lost from the soil. If it becomes deficient in a soil we must obtain it from the air by bacterial action, or purchase it from the fertilizer dealer as nitrate of soda, sulphate of ammonia, blood meal or some other compound. This method proves very expensive, of course.

In the air surrounding the earth there is an inexhaustible supply of nitrogen —about twenty million tons per square mile of the earth's surface, or over sixty million pounds for every acre of land, but as far as the plant itself goes it might as well be on the moon. We are entirely dependent, as far as we know now, on bacteria to take the nitrogen from the air and store it in the soil for the use of plants; that is, by natural processes. The bacteria which can obtain nitrogen from the air we classify into two types, first, symbiotic, that is, working in co-operation with legumes and existing on colonies or nodules on the roots.

Second, non-symbiotic, existing in the surface layer of the soil and not depending on a plant for their existence.

The first type we attempt to increase in our soils by inoculating clover, alfalfa and pea seed before sowing. This is so well known it requires no further explanation. The second type naturally exists in every soil and we only need to bring about suitable conditions in order to rapidly increase the numbers. In both cases the bacteria thrive best in a soil which is neutral—*which condition can only be obtained when plenty of lime is present in the soil.* Thus when lime is deficient, nitrogen fixation, or the taking of nitrogen from the air and storing it in the soil, is at a minimum, and since nitrogen is the most expensive fertilizer element that we must purchase, the lack of lime lessens the cash return from the

land in reduced crops and increases the money paid out for nitrogenous fertilizers in order to produce a crop at all.

To give an idea of the amount of nitrogen stored in a soil in a year we give the results obtained at the Rothamsted experimental station in England, which are probably the most dependable. In this case two fields lay in pasture for twenty years. One containing plenty of lime accumulated nitrogen at the rate of ninety-eight pounds per year. The other, almost deficient in lime, accumulated nitrogen at the rate of forty-four pounds per year. The difference is quite striking and the value of lime in stimulating nitrogen fixation quite evident.

Showing nodules on roots of clover.

Lime and Nitrification

A discussion of lime and its relation to nitrogen cannot be complete without mentioning its effect on nitrification. The principal form in which nitrogen occurs in the soil is organic matter. Nitrogen in this form, however, is of little value to plants, except that in a few of the relatively simple organic compounds. To enable a plant to use it it must be converted first into ammonia compounds and then into nitrates. The first step is termed *ammonification*, the second, *nitrification*. We find that ammonification proceeds almost as well without lime as with lime, except the hydrate and quicklime which accelerate the action appreciably. In the case of nitrification, however, the effect is more marked, the action proceeding much more rapidly in a soil containing plenty of lime than in one which is deficient. Under acid conditions nitrification proceeds sufficiently to produce a medium crop, but only where lime is present are there enough nitrates for maximum production. Lime is not the only factor, however, which influences nitrification as we find it proceeds better with some crops than others. However, we will only discuss two, clover and timothy.

LIME AND CLOVER VS. ACID SOIL AND TIMOTHY

It has previously been mentioned that clover in co-operation with bacteria increases the nitrogen content of the soil. It is also known that as a feed for live-

stock generally clover is preferable to timothy, although the latter has its place. In some sections, due in many cases to acid soils, timothy has completely displaced clover on the farms, and even in some places where clover will grow satisfactorily.

Recent investigations have pointed out that during the growth of timothy nitrification is practically suspended and this condition persists during the following crop. On the other hand nitrification under clover is accelerated and the effect also persists. The effect is, then, that invariably heavier crops are produced after clover than after timothy. This is a point worth noting. Therefore if the lack of clover is due to soil conditions, and lime will correct the trouble, it is advisable to use lime and grow clover rather than to cultivate an acid soil and grow timothy.

EFFECT OF LIME ON THE PHYSICAL CONDITION OF SOILS

If a soil be placed under a microscope or a strong lens it will be seen to be composed of particles of gravel, sand, bits of decayed vegetable matter and fine particles which we may term silt and clay. If a portion is placed in water and shaken up, some will settle quickly and part will remain in suspension for a long time. In fact it is doubtful if all of the particles ever settle. This portion of the soil which remains in suspension is what is termed colloidal matter, and the sticky, adhesive qualities of clay are due to the large colloidal content. Sandy soil contains little colloids and as a result is not inclined to become so adhesive and difficult to work.

In order to improve the physical condition of soil two factors must be recognized—organic matter which loosens up and renders the soil more porous, and the effect of lime which causes numbers of these very fine particles to unite, forming a comparatively large floc. These larger particles do not form such a compact mass and hence, the physical condition of the soil is improved. This action is generally termed flocculation.[1]

It has been further pointed out that besides putting the soil in better condition for plant growth, the addition of lime in a clay soil causes an appreciable decrease in the labour performed by horses in ploughing: since the soil is more friable and less inclined to puddle, the plough penetrates more easily and not so much energy is expended by the team in turning the land over. In speaking of the physical effect of lime on soils it must be recognized that the hydroxide (slaked lime) is the most effective as a soil flocculant, which is an additional argument for its use in preference to the carbonate. The price being equal, it would probably be good business to use this form on heavy soils.

LIME ON LAWNS AND GOLF COURSES

The outward beauty of a house depends largely on the surroundings. Well spaced plantings of trees, shrubs and flower beds, with lawns between, greatly enhance the beauty of any building. A large proportion of lawn lends beauty to the whole setting and a view over an open greensward, bordered by shrubbery gives a charm to the picture of the home and suggests comfort. A good lawn can be produced under almost any conditions. Space will not permit of a detailed

[1]As is generally known, the hydroxides of ammonium, sodium and other elements act as deflocculating agents in soil suspensions. Thus it is difficult to explain the action of calcium hydroxide unless we consider the clay particle to be surrounded by a film of gelatinous matter, probably colloidal silica—really a protective colloid. The calcium hydroxide combines with this protecting emulsoid matter, forming a coagulum, which entrains the particles causing flocculation.

description here of the method of constructing a lawn; sufficient to deal with the use of lime in its establishment.

We have two alternatives in lawns. In one we start with an acid soil or one which has very little lime in it and proceed to make it more acid, growing on it types of grasses which are acid resistant, such as the bents and red fescue. This is the method used on putting greens. It is well suited to the conditions required, a short thick turf which will withstand close cutting and be almost entirely free from clover and weeds. In this system no lime is used and fertilizers known to leave acid residue are used entirely.

The other method is where we start with a soil which has too much lime in it to enable us to grow the bent grasses. Therefore, we add more and grow grasses which like plenty of lime, with a good sprinkling of white clover. This system gives a nice clean lawn for general purposes and is suitable for ordinary house lawns and fairways on golf courses. For this type of lawn use about 2,000 pounds slaked lime per acre, two weeks before seeding, or 3,000 pounds crushed limestone at the same time. This makes positive the growth of clover

Lawns and shrubbery add to the appearance and value of a farm.

and the rapid decay of organic matter, which liberates plant food and keeps the lawn green and healthy.

This system of lawn formation does not give as weed free a lawn as the first method, but if seeded each year the thick grass will crowd out the weeds fairly well. A lawn of this type should be limed with crushed limestone every third or fourth year in addition to any other fertilization.

THE DISTRIBUTION OF ACID SOILS IN SOUTHWESTERN ONTARIO

Field and laboratory investigation carried on in connection with the Soil Survey, has shown that approximately 30 per cent. of the area surveyed in the preliminary soil survey of Southwestern Ontario contains acid soils.

The accompanying map indicates the distribution of the areas in which acid soils are most frequently found and affords comparison of their extent with areas in which acid soils do not commonly occur.

It is of interest to note that the areas in which the acid soils occur are confined to belts of land along Lakes Huron, Erie, Ontario, the peninsula between Lakes Huron and Erie, the Niagara Peninsula and between Georgian Bay and Lake Simcoe.

These areas roughly lie just within the beds of the post-glacial lakes that once covered the Province. The soils during their deposition were subjected to vigorous water action, and were laid down under conditions which tended to accentuate leaching of the soluble calcium and magnesium in the upper layers, and therefore to cause them to early become acid soils.

In the central and eastern area where mainly non-acid soils occur, the land surface, though covered with glacial ice, was not for any length of time covered with glacial lake waters. The soil material is largely limestone, and this, coupled with the fact that the soils during their deposition were only subjected to slight water action, accounts for the general high lime content found in the area.

In Essex, West Kent and Lambton, the non-acid soil area, though lying in the old glacial lake bed, represents soils derived mainly from limestone material, deposited in deep waters, fed by streams carrying soluble lime from the uplands from which they flowed.

The areas including acid and non-acid soils respectively are characterized by distinctly different soil series, and the relationship of these soil series to their

A limestone outcrop from which lime may be obtained.

respective areas has been shown by our Soil Survey to hold good for nearly all localities.

In the frequently occurring acid soil areas are to be found soils of the Dunkirk, Haldimand, Milton, Lockport, Hastings Series. (See Bulletin 298, Preliminary Soil Survey, Southwestern Ontario, for description of these soils.) Of the Dunkirk series the fine sand, sandy loam, loam, and silt loam types are most likely to be acid, at least in the surface soil. The Dunkirk fine sand and sandy loam are often acid to a depth of two feet or more. In the Haldimand series, the two types, clay loam and clay—are both found in the acid soil area.

The Milton loam and clay loam to a limited extent occur as acid soil types. The Hastings stony clay loam, confined wholly to the eastern part of the surveyed area is variable, but frequently occurs as an acid type.

The soils enumerated above, except the Hastings series, have been for the most part derived from sandstone and shale material, hence, from the first, have not inherited an abundance of lime. What small amount there was in the surface soils has been gradually leached downward until these soils have, over most of their extent, become acid.

In the area of non-acid soils, the Guelph, London and Clyde series are found. Derived mainly from limestone, with some crystalline rock influence, they are

naturally high lime soils. Where these soils occur, generally speaking, seriously acid soils are not to be found. It must not be concluded, however, that these soils may never become acid. While at present they have sufficient lime in their surface layers and an abundance in the subsoil below, this supply is being slowly yet surely depleted, as in all soils, irrespective of nature and occurrence. For this reason, then, in local areas where this exhaustion has taken place more rapidly than in general, even in the area mapped as containing non-acid soils, we may find exceptions to the rule. But at present, at least, crop plants grown in that area are not seriously suffering for lime.

The value of the accompanying map lies in the fact that it indicates largely the "danger zone" where soils lacking in lime are known to exist, and that it may serve to sound a note of warning to farmers in these areas to have acidity tests made on their farms and determine the need for lime.

By serving such purpose it may play a small part in our programme of soil fertility conservation, which is so essential to the prosperity and well being of our nation.

Limestone boulders in high lime area.

RESULTS OF USE OF LIME

On Experiments Conducted by Department of Chemistry, O.A.C.

In the fall of 1922 experiments were projected by the Department of Chemistry, O.A.C., for the purpose of demonstrating throughout the Province the effect of lime alone and with suitable artificial fertilizers on fall wheat and clover.

With the co-operation of the district representatives three farms were selected in each of eight counties, Halton, Peel, Wentworth, Lincoln, Welland, Haldimand, Norfolk and Elgin. The experiment was laid down in four plots as follows:

Plot 1.—Check (no treatment),
" 2.—Lime (Crushed Limestone 2 tons per acre).
" 3.—Lime (as above) and Acid Phosphate (400 lbs. per acre).
" 4.—Complete fertilizer.

The farms chosen were inspected by the soil research chemist of the Department and the location of the plots decided after discussion with the owner. Each plot consisted of one-half acre, the shape and position being decided in order to avoid abrupt soil variations.

The lime was applied early in August as far as possible and harrowed in. The fertilizers were applied a few days before seeding the wheat or during seeding by means of a fertilizer attachment on the grain drill.

MAP OF SOUTHWESTERN ONTARIO

Showing Areas In Which

ACID SOILS

Most Frequently Occur

Effect of Lime on Yields of Wheat

It was not expected that significant results would be obtained from the use of lime on wheat, since cereal crops rarely respond to lime. This is borne out by the yields obtained. On an average of nineteen experiments in 1923 the check yield was 22.2 bushels per acre, while the limed area gave 22.41 bushels per acre. The same experiments, spread over eight more counties in 1924, yielded on an average, check 23.78 bushels, limed 26.92 bushels. This shows an increase of slightly over three bushels per acre, which is within the limit of error and therefore cannot be attributed to the lime.

Effect on Yields of Clover

The wheat was in the majority of cases seeded down with clover or alfalfa, except a few fields in which the wheat was winter-killed and ploughed up. For various reasons results were not secured on some of the plots, so that out of the original twenty-four laid down clover was harvested on ten only. The results

Results of lime on second year alfalfa. Lincoln County.

are given on the following table and show conclusively that lime will give results on clovers in these counties. The increase from 7 to over 100 per cent. is quite striking.

Yields were also obtained in several cases on the second year cut of hay showing an increase of about 40 per cent.

The following table gives the results obtained.

Series I.—Yields of Clover Obtained in 1924. Seeded Spring 1923.

Expt. No.	County	Soil Type	Crop	Check — Hay Lbs. per Acre	Lime— Hay Lbs. per Acre	Increase Lbs. per Acre	Per cent. Increase
6	Norfolk.....	Norfolk sandy loam.	Red Clover..	4,448	6,912	2,464	55
12	Halton.....	Milton Clay.....	Alsike.....	3,088	3,584	496	16
13	Wentworth...	Haldimand Clay....	Red Clover..	2,960	3,616	656	22
16	Welland.....	" ...	"	2,832	3,808	976	34
17	Welland.....	" ...	"	2,752	4,064	1,312	22
18	Welland.....	" ...	"	1,280	2,496	1,216	95
19	Haldimand...	" ...	Alfalfa.....	3,888	4,528	640	16
20	Haldimand...	" ...	Red Clover..	5,336	5,728	392	7
22	Lincoln.....	" ...	"	1,984	3,600	1,616	81
24	Lincoln.....	" ...	"	2,212	4,976	2,764	124

Second Series

In the fall of 1923 eight more counties were chosen and three experiments placed in each. These counties were Kent, Essex, Lambton, Oxford, Middlesex, Peel, York and Ontario. Of these clover was cut on nine only, the others being lost due to different causes.

Lime, as in first series, showed no appreciable effect on the yield of wheat, the average check yield being 23.78 bushels and lime yield 26.92 bushels per acre.

On the clover yields, however, substantial increases were shown except in York and Oxford Counties where no increase is noted. The increases as seen in Table Series II range from 21 to 82 per cent.

Thus you can see that lime will give results on clovers when the soil is acid and has little or no effect on wheat. At the same time it may give no results on your land. The best way to decide is to send a sample to the Department of

Showing results of lime on clover. Oxford County.

Chemistry where it will be analyzed and a report sent to you. Then if it is acid, lime a strip and note results before investing heavily in lime.

Series II.—Yields of Clover Obtained in 1924. Seeded Spring 1924.

Expt. No.	County	Soil Type	Crop	Check — Hay Lbs. per Acre	Lime— Hay Lbs. per Acre	Increase Lbs. per Acre	Per cent. Increase
26	Essex.....	Clyde Clay.....	Red Clover..	1,286	2,160	874	68
33	Middlesex....	Haldimand Clay....	"	1,664	3,024	1,360	82
36	Lambton.....	Haldimand Clay....	Alsike.....	1,504	2,492	988	65
37	Oxford.....	Heavy Guelph Loam	Red Clover..	960	1,920	960	50
42	York.....	Guelph Loam.....	"	6,144	4,656	....	..
43	York.....	Guelph Loam.....	Alfalfa.....	4,288	3,520	....	..
44	Norfolk.....	Norfolk V.F.S. Loam.....	Red Clover..	2,352	3,098	746	31
45	Kent.....	Clyde Clay.....	"	2,611	2,912	301	11
46	Oxford.....	Guelph Loam.....	"	2,752	2,048	....	..

No. 44 had two crops of wheat in succession before being seeded down.

APPENDIX

METHODS FOR DETERMINATION OF SOIL ACIDITY

(For District Representatives and others having equipment.)

1. Hydrochloric Acid Test for Carbonates, as previously described. Page 7.
2. Litmus Test for Acidity, as previously described. Page 8.
3. Truog Method.

Apparatus Required

1. Truog Apparatus. Price, about $10.00.
2. Or the following:
   (1) One 500 cubic centimetre Erlenmeyer Flask.
   (2) One 100 cubic centimetre graduate.
   (3) One metallic cylindrical measure, inside diameter three-quarters inch, depth one and one-eighth inches.
   (4) One steel spatula.
   (5) Gas burner or alcohol lamp.
   (6) Mixture of barium chloride and zinc sulphide, six to one, intimately ground together.
   (7) Lead acetate paper made by soaking clean filter paper in saturated solution of lead acetate and drying in a room free from fumes of hydrogen sulphide.

NOTE.—The Department of Chemistry, O.A.C., Guelph, is prepared to supply at cost the chemicals and lead acetate paper to District Representatives, school teachers and anyone else carrying on educational work.

METHOD OF PROCEDURE

1. Measure into Erlenmeyer flask one metallic measure of the soil well tamped down.
2. Add 100 cc. of distilled or very pure rain water.
3. Add the small measure, supplied with the apparatus, level full of reagent or what will cover a large Canadian five-cent piece.
4. Heat to boiling, shaking occasionally to prevent breaking the flask.
5. One minute after boiling begins, place across the mouth of the flask a strip of lead acetate paper, which has been moistened with a drop of water, and continue boiling for two minutes longer.
6. Then remove, dry the paper and compare with the colour chart, which may be obtained with the apparatus.

Explanations.

This method is based on the power of the acidity of the soil to liberate the hydrochloric acid from barium chloride, which attacks the zinc sulphide liberating hydrogen sulphide. The H_2S combines with the lead acetate to form lead sulphide, thereby darkening the paper.

Reactions are as follows:—$2HA + BaCl_2 — {}_2HCl + BaA_2$

${}_2HCl + ZnS — H_2S + ZnCl_2$, $H_2S + Pb(C_2H_3O_2)_2 — PbS + {}_2HC_2H_3O_2$

NOTE.—In purchasing Zinc Sulphide care must be taken to get the monosulphide of zinc. The higher sulphides liberate free sulphur and a strongly acid soil will not produce the slightest change on the lead acetate paper.

Thiocyanate Method

Apparatus Required.

(1) One dozen test tubes, test tube rack and brush.

(2) Reagent, being a 5 per cent. solution of ammonium sulphocyanate NH_4CNS, or potassium sulphocyanate KCNS, in 95 per cent. denatured alcohol. (Make up by adding five grams of solid to 100 cc. of 95 per cent. denatured alcohol.) Shake till dissolved. If a pink colour develops, add drop by drop a NaOH solution until pink colour disappears.

Details of Procedure.

Fill the test tube one-quarter full of soil and add an equal quantity of the reagent. Shake several times and place in rack to settle. Note the colour of the clear supernatant liquid, and compare with colour chart.

When there is a deficiency of calcium or magnesium carbonate in a soil the aluminium and iron present combine with any free acid radicle to form salts of these metals. If an alcoholic solution of potassium thiocyanate is added to such a soil the solution will acquire a red colour, the intensity of which has been shown to be approximately proportional to the acidity in the soil. Or if an alcohol solution of logwood be added, a blue colour will develop, the intensity of which is again proportional to the concentration of both aluminium and iron in the soil extract.

As an explanation of this colour formation it may be supposed that, in an acid soil, iron and aluminium exist in the form of partly hydrolized largely colloidal salts in equilibrium with the weakly ionized soil acid. These salts are capable of reacting with such salts as potassium thiocyanate, which would not be true of insoluble oxides or silicates, such as would be present in a neutral or basic soil. This might be expressed thus:

(1) $FeA_3 + H_2O — FeOH.A_2 + HA$

(2) $FeOH.A_2 + 3KCNS + HA — Fe\ (CHS)_3 + 3KA + H_2O$

Where A represents any acid radicle. The ferric thiocyanate thus produced colours the solution somewhat in proportion to the amount of acid which made iron available for this reaction.

For those who wish to study the subject further the following references may be of value:

1. Journal of Agr. Science, Vol. 10, p. 420 (1920).
2. Journal of Industrial and Engineering Chemistry, Vol. 13, p. 931 (1921), or any good text on Soil Chemistry.

Soiltex Soil Acidity Test

This test, which has been developed by the Dept. of Soils, Michigan Agr. College, has been placed on the market within the last year and, when used properly, is fairly satisfactory. It is simple, rapid in action and very sensitive —its sensitivity being its greatest objection.

The only equipment required for performing the test is a dropping bottle full of Soiltex solution, a pad of neutral waxed paper strips and the Soiltex colour chart.

The procedure of the test is as follows: A strip of waxed paper from the pad is folded lengthwise to form a trough. With a clean knife blade place a small

quantity of the fine soil to be tested (the amount would cover a dime) loosely in the trough. Drop the solution slowly on one end of the solid mass until the soil becomes saturated with the solution and one drop remains in the trough. Let the mixture stand for a minute, then tip the paper slightly so the solution may run through the soil (not over it), then carefully draw some of the clear liquid away from the lower end of the mass and compare the colour of this soil extract with the colour chart supplied with the Soiltex outfit in order to determine the soil reaction and the recommended lime requirement if the soil is acid. The colour chart shows the colour range of Soiltex solution, gives the soil reaction, and the tons of limestone required per acre under average farm conditions.

This method, of course, is simply the application of one of the newer indicators, bromthymol blue, to soil study, and put on a commercial basis. This indicator has been used by the Department of Chemistry for the last three years, and while it proves very satisfactory in the hands of an experienced person, the inexperienced are apt to overestimate the importance of the acidity as indicated by it.

The indicator is so sensitive that the colour may be changed merely by blowing the breath on it, the carbon dioxide forming acidity sufficient to influence the colour. It is evident, then, that the range covered is not sufficient to measure the acidity where it is present in a fairly great concentration.

Organic matter has a tendency to remove the colour from the solution and errors will be made in estimating the degree of acidity of soils having a high organic matter content.

This test has been given a year's trial in comparison with other tests on soil survey field work, and among other points one is very noticeable—*that very frequently alfalfa and sweet clover are found growing luxuriantly on soils indicated acid by this method.* As a method of determining the amount of lime to be applied to soils this fact is sufficient to cause it to be discarded and *farmers will be wise to question lime requirements so determined.*

If the method be used, it is valuable only to indicate acidity or alkalinity and *unless the indicator gives a clear yellow colour* lime should *not* be applied, and when it is applied it should be not more than two tons.

The Department of Chemistry is at present working on a combination method of determining lime requirement, which should be available within a year, correlated with actual results on Ontario soils. Until this is completed, farmers are warned as to purchasing lime as recommended by anyone except the above department.

In case science teachers wish information as to the proper indicators to use, and the technique, the information will be given by this department.

Other Methods

There are many other methods of determining soil acidity which cannot be dealt with here. Many work very satisfactorily, but probably for ease and rapidity those mentioned are the best. Further information as to methods can be obtained from Department of Chemistry, O.A.C.

ADSORPTION IN SOILS

In order to make clear the action of soils when brought into contact with litmus or with any other neutral salt, the authors deem it advisable to give an explanation for the better understanding of such reactions by science teachers, teachers in rural schools and others who may be interested.

The colloidal content of soils has already been mentioned. By colloidal matter is meant those particles ranging from that just visible under a microscope to the size of the molecule in a true solution. These colloids have the power of condensing or attracting to their surface the molecules of gases, or of solids in solution, and may when brought into contact with a solution exercise selective adsorption. For example, in a solution of salt (NaCl) two ions are liberated, the sodium ion (Na^+) and the chlorine ion (Cl^-). One of these may be more strongly adsorbed than the other—the Na^+ ion being adsorbed and the Cl^- ion left in solution. The Cl^- ion combines with any base or salt present, generally calcium, and calcium chloride is found in the drainage water.

Other substances have the power of adsorbing ions of salts as well. 1. Blue litmus paper is simply the sodium or ammonium of an acid, and when brought into contact with pure cotton the Na^+ ion is adsorbed preferentially and the acid released. This, of course, causes the blue litmus paper to turn red, thereby indicating acid—*when there is no acid present.* If, however, enough base is added to the cotton before it is brought in contact with the litmus paper no effect will be seen. The adsorbing power of the cotton has been satisfied.

Similar action takes place in a soil which is brought into contact with litmus paper. If the soil has plenty of bases present it will not affect the litmus, but if there is base deficiency the basic ion will be adsorbed from the litmus paper, turning it red. This is ordinarily known as acidity (1) but in a soil is really base deficiency. On some soils sufficient bases, calcium, magnesium, etc., are present so that adsorption does not take place and there is no action on litmus.

When a salt of potassium, sodium or calcium is added to a soil an exchange of bases takes place. If the soil has plenty of lime present the corresponding salt of calcium will be found in leachings. If lime is absent or nearly so, the corresponding salt of aluminium, iron or manganese is formed. These salts hydrolyze in solution, giving free acid, and such acid is measured. The acid released is therefore not the free acid which is present in the soil, but that which is released by base exchange. Nearly all the methods of determination of lime requirement are based on this theory, and while we cannot consider them accurate they are possibly as good as any we have.

The only accurate method of determination of acidity is by measuring the hydrogen ion concentration either electrometrically or by use of indicators. It must be remembered, however, that the hydrogen ion concentration has not been correlated with the beneficial effects of lime when applied. Some authorities state that there is no correlation, but the fact remains that true acidity can only be estimated by this method. At the same time such methods as are at present available for public use are limited in their application to the soils of Ontario and are not recommended for general use.

(1) To define acidity—where there exists a greater concentration of hydrogen ions than of hydroxyl ions.

Further information and references for further study will be supplied to teachers and others on request by the Department of Chemistry, O.A.C.

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BULLETIN 314] [FEBRUARY, 1926

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

VEGETABLE GARDENING

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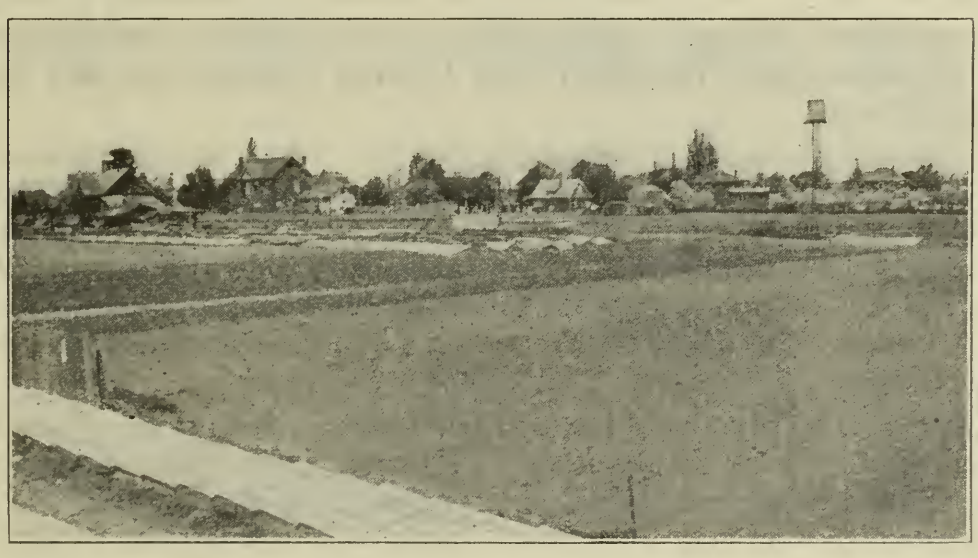


INTRODUCTION

The subject of vegetable growing is probably one of more interest to a greater number of people within the Province of Ontario than is that of any other single branch of agricultural activity. Almost everyone who has lived in the country, in a small town or even in the residential sections of larger cities, has at some time or other been actively interested in gardening and the growing of vegetables. As a pastime and a hobby it holds a place with many folks, while from the utility standpoint the home garden is a means of supplying, at little cost, a very valuable part of many families' food supply. The commercial production of vegetable crops within this province is fast developing into an industry whose importance rivals that of any of the major branches of farm crop production.

Vegetable Gardening may be classified into different divisions, according to the extent to which it is developed and the nature of the crops grown. These divisions are (1) Truck Gardening, (2) Market Gardening, (3) Production of Canning Crops, (4) Vegetable Forcing, (5) Home Gardening.

(1) *Truck gardening* is the term applied to the production of one or more special vegetable crops in quantity and for shipment to outside markets. It is

extensive in one sense and yet intensive methods of culture are practised with some of the crops, such as celery and onions. In Ontario, the main truck growing sections are mostly located in southwestern Ontario, in the counties of Lambton, Essex, Kent and to some extent in Elgin, Norfolk, Welland, Lincoln, Wentworth, Halton and Peel counties.

(2) *Market gardening* is the term applied to that branch of gardening which aims to produce vegetables for a local ,market. Since market gardeners are usually located near towns or cities their land value is high and of necessity more intensive methods of cultivation are employed. Also, the market gardener usually grows a wide variety of vegetables to meet the demands of his trade. In the vicinity of Toronto is to be found the most highly developed market gardening section in the province.

(3) *The production of canning crops* is an important division of the group. It is estimated that the value of the annual tomato pack in Ontario is in the neighbourhood of $3,000,000, and this is but one of several canning crops grown. Southwestern Ontario is again of chief importance in providing suitable areas for the production of these crops, although the counties bordering on Lake Ontario, eastward from York to Prince Edward County, are also important producing sections.

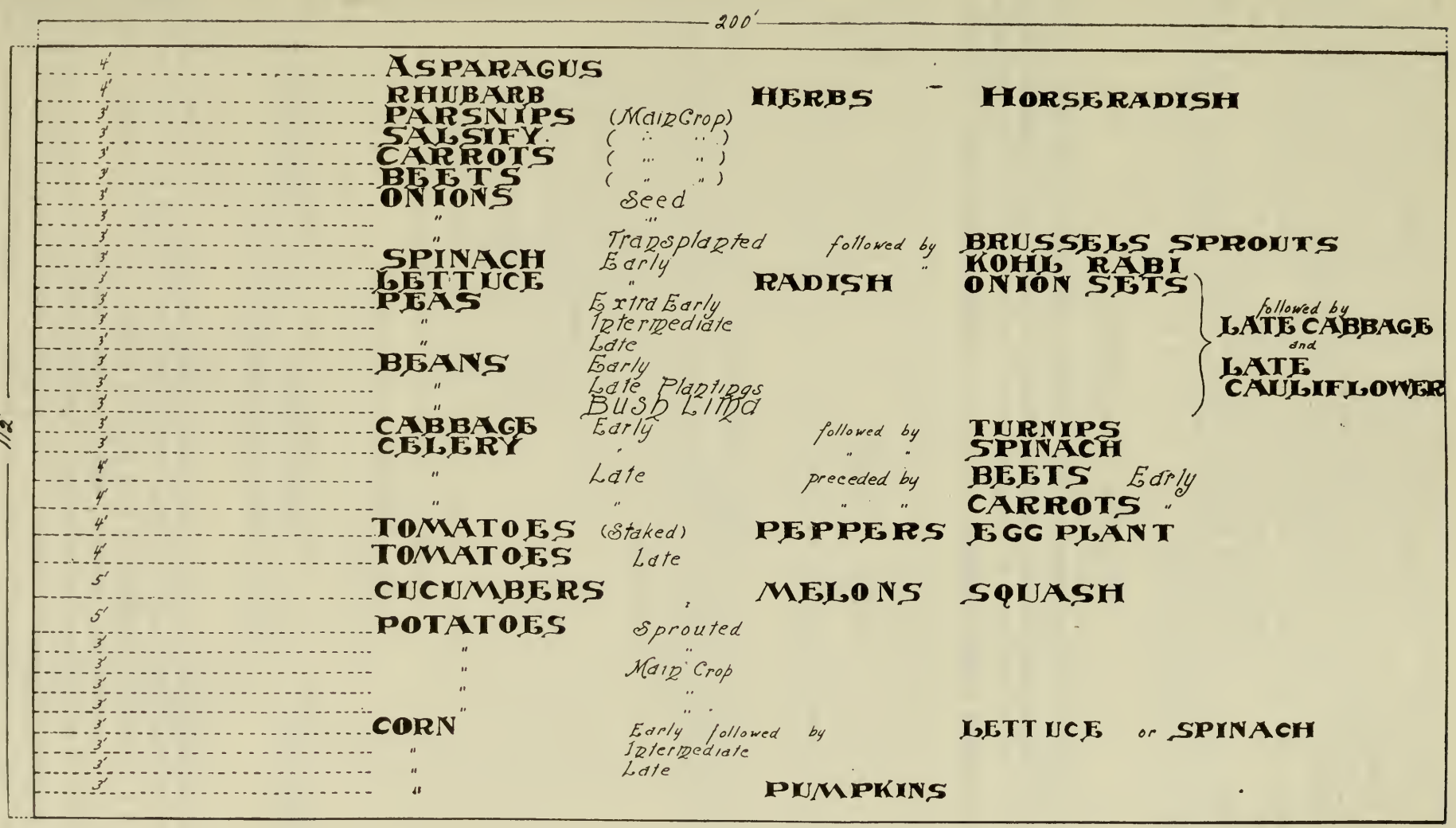
(4) *Vegetable forcing* as a special division may be classified under our conditions as that division which has to do with the growing of vegetables out of their normal season and under glass. For this purpose greenhouses are chiefly used for large scale production. This specialized industry is located chiefly from the Toronto district westward, following the lake-shore counties, through to Essex county. The district surrounding London is also quite important in this respect.

(5) *Home gardening*, the oldest and best known division, has to do with the production of vegetables for home use. Its great importance is shown by the following figures, which are an estimate of the value of vegetable crops grown in farm gardens in Canada. The value is placed conservatively at $10,000,000, and this figure does not include the value of home garden produce grown in cities and towns or villages.

In this bulletin it is impossible to discuss all of the above-mentioned divisions separately. Vegetable forcing in itself is so highly specialized that it will not be included in the general discussion of crops. There are a few rules and suggestions peculiar to home gardening and these are dealt with under separate headings. The remainder of the bulletin is devoted to a general discussion of vegetable growing, some of the principles involved and brief cultural directions for the more important crops. The information presented is planned so as to offer assistance to both the small gardener and the commercial gardener, for the fundamental principles that govern the one apply equally well to the other.

PLANNING THE HOME VEGETABLE GARDEN

If the garden crops are planted according to a definite plan much better results can be expected in obtaining the most efficient use of small areas of land. Seed may be purchased early in the season and equipment can be provided before it is actually needed. The planting list should include vegetables that will, as far as possible, provide a supply of fresh vegetables throughout the whole season, as well as allowing for a surplus to be canned and stored. There are many vegetables not widely known or used which should be found in every home garden, as well as the more commonly grown sorts.



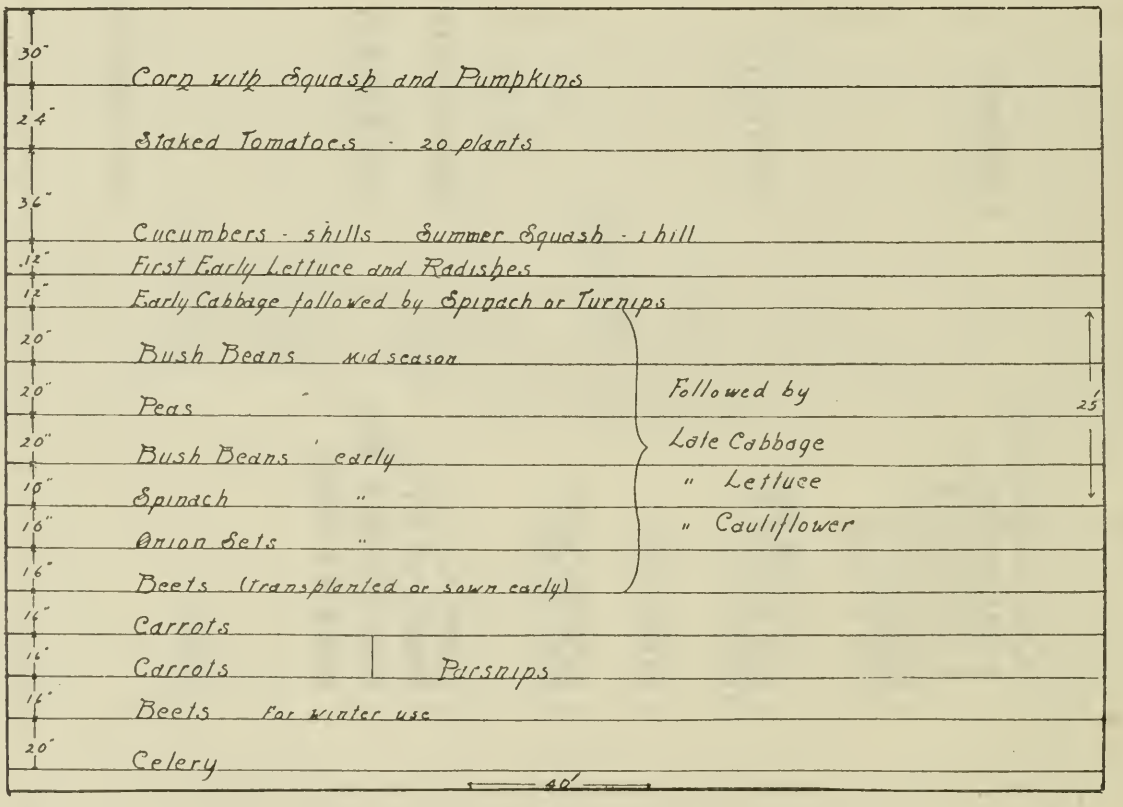
Plan for a farm home garden 200 ft. by 112 ft. The rows are spaced to permit of horse cultivation.

Size and Location of the Garden

In the city the location of the garden is usually a matter where little choice is left to the grower. The size also depends on the space available. In the country, however, more choice of location of suitable areas is possible. A garden of one-quarter acre may be made to supply a family of five or six persons where attention is paid to succession and intercropping. A somewhat larger garden may offer more ease of cultivation and care. Where possible, the choice of a southern or southeastern slope gives an earlier garden site. On farms it is a good plan to have the garden located near the house, since the work is mostly done in spare time and it also is much handier for the housewife to gather vegetables from it as she needs them.

Plan and Arrangement

The plan and arrangement of the garden depend upon its size, location, slope of the land, and the kind of cultivation to be given. In small backyard gardens it is often necessary to practise very intensive cultivation methods and crops are planted closer together with more attention being paid to succession



Plan for a small home garden 40 ft. by 25 ft.

and intercropping than in larger gardens. Where possible, it is a great advantage to be able to plan the rows so that a wheel hoe may be used to cultivate. Some backyard gardens are shaded for the greater portion of the day and in such the leaf crops, as lettuce and spinach, will give best results.

For the farm garden, where there is usually plenty of room available, more definite suggestions may be made. The garden should be longer than broad to allow for long rows spaced for horse cultivation, at least thirty inches wide and up to four feet with the larger crops. Turning room at the ends is also necessary. Where fruit trees or bushes are located in the garden they should be at the side

from which direction the prevailing winds come. Perennial crops, as asparagus and rhubarb, ought also to be placed at one side or end of the garden where they will not interfere with the plowing of the garden. Tall-growing crops are best planted together, where they will not shade the lower-growing sorts. Long season crops are best planted together, while the quick-maturing crops should follow one another in successive or contiguous rows in order that the land may be conveniently planted out to later crops after their harvest.

SUCCESSIONAL PLANTING

In order to have a fresh supply of vegetables on hand during the early summer months, seed may be sown at intervals of a week or ten days until June 1st. This will greatly improve the quality and give a more general run of popular crops. The following crops may be handled in this way: Corn, radish, lettuce, spinach, endive, beets. When successional plantings are made only a short row should be used for those requiring only a small supply. For the vegetable grower longer rows will be necessary, but care should be taken not to over-plant.

Several growers of lettuce on quite a large scale plant a certain amount each week, and in this way are assured of a fresh crop every week or ten days throughout the season. By doing this they do not overload the market at any time and their customers have fresh, well-grown lettuce in constant supply.

Successional plantings are not limited to one crop. One crop may be grown to maturity and harvested, and the ground immediately planted with another crop of entirely different nature. This again may be followed with still another crop, in many sections under careful management. Successional cropping is practised by many of the more progressive vegetable growers, and, while there is considerable labour attached to this method of vegetable growing, the returns per acre are oftentimes doubled and tripled on small acreages.

Some examples of successional plantings are as follows:

Spinach, followed by celery.
Early potatoes, followed by late celery.
Lettuce, followed by turnips.
Lettuce, followed by cabbage.
Lettuce, followed by parsnips.
Cabbage, followed by celery.
Peas or beans, followed by winter radish.

GROUPING OF CROPS

Crops that occupy the ground the entire season	Early crops that may be followed by others	Late crops that may follow others
Beans, lima (both bush and pole)	Beans, bush	Beans
Corn, late	Beets, early	Beets
Cucumbers	Cabbage, early	Cabbage, late
Eggplant	Carrots, early	Carrots
Melons	Corn, early	Cauliflower
Onions from seed	Lettuce	Celery
Parsnips	Peas	Corn
Peppers	Potatoes, early	Kale
Potatoes, main crop	Radishes	Lettuce
Pumpkins	Spinach	Peas
Salsify	Turnips	Spinach
Squash		Turnips
Tomatoes		

INTER-CROPPING OR COMPANION-CROPPING

Where two or more crops are grown on the same soil at the same time it is known as inter-cropping or companion-cropping. By this is meant that crops maturing at different times are planted together, and when one is ready for market it is cut and the other one left until it reaches maturity. Inter-cropping is practised on small pieces of land and with good success. Larger returns can be had from this method than any other. The land must be practically full of manure in order to grow the crops quickly and not allow them to become starved in any way. Inter-cropping practically prohibits horse cultivation, and for this reason many vegetable growers do not follow this practice to any extent.

The following examples explain:—

(1) Cabbage in rows three feet apart.
Two rows of spinach 8 to 10 inches apart in between.

(2) Early lettuce and beets 10 to 12 inches apart.

(3) Horse-radish in permanent rows three feet apart.
Cabbage in between the sets.

(4) Corn and pumpkins, both permanent crops.

(5) Parsnips in rows three feet apart.
Early beets pricked out in between rows.

CROP ROTATION

Successful gardeners have learned to practise crop rotation from their own experience. Many advantages of such a system of management are offered, the following are six of them:—

1. The control of insects and plant diseases is aided.
2. The drain on the supply of raw materials in the soil tends to be equalized.
3. Injury caused by poisonous substances in the soil is either prevented or reduced.
4. Plant food supplied to the soil is utilized with greater efficiency.
5. Gardening is systematized.
6. The soil is kept in better physical condition.

The following are recommendations to be observed in planning a rotation:

1. Alternate shallow-rooted and deep-rooted crops.
2. Follow crops which furnish organic matter with those which favour its rapid decomposition.
3. Vary the crops in rotation as much as possible in respect to the kinds and amounts of nutrients required, character of root growth and time of year during which they occupy the soil.
4. Allow as much time as practicable for the growing of soil-improving crops.

SOILS AND SOIL PREPARATION

Kind of Soil

The soils preferred for vegetable production are sandy, sandy loam, clay loam, silt and muck. A sandy loam soil is probably the most popular, but each type has its limitations and some crops are suited better to one than another. Where a range of soils exists in a garden, advantage should be taken of this fact.

Soils of a sandy nature are early soils, because they dry out and warm up early in the spring. Likewise they are not suited to late growing crops for this reason. In general they are low in fertility and must be fed heavily in order to build up their fertility and moisture-retaining ability.

Clay loams are better retainers of moisture than either sands or sandy loams and are also richer. However, they are not suited, so well, to growing early crops. Crops grown during the drier part of the season find more moisture in this type of soil, and hence we find such crops as late cabbage, late cauliflower, late potatoes, canning factory sweet corn and tomatoes grown extensively on such soils.

Muck soils, on account of their high organic content, their moisture-retaining ability and the ease with which they can be worked are considered better than any other, especially for the production of celery, lettuce and onions. They are also sometimes used for growing potatoes, beets, parsnips, cabbage, cauliflower and spinach, but are not suited to early crops or long season tender crops.

Soil Preparation

Especially for vegetables is thorough soil preparation necessary to ensure successful crops. Poor preparation shows up all throughout the season and results in poor crops.

Drainage.—This is the first step in preparing the heavier types of wet soils. Good drainage is essential with the soil requirements of practically all vegetable crops. Ditches and tile drains are found to be most satisfactory and soon pay for the cost of installation. Better aeration of the soil results, followed by increased fertility and earlier and warmer soils.

Plowing (or Digging).—Deep soils are needed by vegetable crops. The deeper the soil the more moisture it will hold and the greater will be the feeding area offered the roots. Plow deeply, though to deepen a soil it is often necessary to do it gradually. Year by year a little more of the lower soil is turned up.

Fall plowing may be said to be generally desirable on all soils, especially clay types, where practicable, and always for sod. Some of the advantages are, the improvement of physical condition of the heavier soils, the control effect on

insect pests, the earlier preparation of the soil possible in the spring and the decay of coarse materials turned under in the fall.

Spring plowing should be done as early as possible, though with clay soils, if plowed too wet, they will puddle and bake. On the other hand, if allowed to dry out such soils are very lumpy. When, after squeezing a handful of soil in the hand, pressure is released and the soil gradually crumbles and breaks up it is in good condition for plowing.

Harrowing.—This operation should follow as early in the spring as the ground is fit after fall plowing and should follow immediately after spring or summer plowing. The hand cultivator, rake and hoe, are the small gardener's implements for such operations. For the heavier soils and for sod, the disc-harrow is invaluable. After its use the spike-tooth or spring-tooth harrow should be used to pulverize and level the soil. A spring-tooth harrow is a much better pulverizer. As a finishing harrow the Meeker smoothing harrow is very excellent and should be more widely used just before seed sowing or transplanting.

Dragging and Rolling.—Heavy soils in particular are often lumpy. A heavy plank drag and roller are often used to break up the lumps. Either may be used alone or both are sometimes used hitched together for light soils and mucks, to compact and smooth the soil surface just previous to planting.

Manures and Fertilizers

Any soil, no matter how good originally, if cropped continuously will become run down and worthless, providing it is not fed and its fertility maintained and built up. Soils devoted to vegetable production are in constant need of humus producing and fertility supplying materials being added.

Stable Manures. Stable manure is the best all-round fertilizer for the garden. It supplies both plant food and humus. The humus keeps the soil open and friable and helps retain moisture. When obtainable it is applied at rates of from fifteen to forty tons per acre. However, of late years, owing to its scarcity, growers have been learning that a smaller application of manure plus some commercial fertilizer gives splendid results. Manure is deficient particularly in phosphorus and with practically almost all vegetable crops it is well to use at least four hundred to five hundred pounds per acre of acid phosphate (sixteen per cent.) or some other form of available phosphorus bearing material. Applications of manure for the small garden would not be too heavy if applied at the rate of two hundred pounds to one hundred square feet and of acid phosphate from two to three pounds to the same area.

Poultry manure is valuable particularly for the leaf crops. Care must be used in its application with plants like the tomato, lest the ammonia fumes burn the plants or the manure cause too much leafy growth at the expense of fruit.

All farm manures are useful, though horse manure is the sort most widely used, since it is largely obtained from city stables. Coarse, fresh manure should be applied in the fall, and only well-rotted manure ought to be used in the spring.

Commercial Fertilizers. Commercial fertilizers may be used successfully to supplement a scant supply of stable manure and to make up the required quantities of the different elements which are needed by particular crops. The growing shortage of manure is a problem that is causing market gardeners and truck growers to reorganize their system of soil management. Green manuring crops, supplemented by the use of studied applications of commercial fertilizers,

are proving their value as soil fertility agents and it is not uncommon to find growers to-day who rely on this system to take the place of the stable manure formerly used. For general use in small gardens a complete fertilizer, that is one ready mixed, containing about four per cent. of nitrogen, eight per cent. of phosphorus and four per cent. of potash, should be fairly satisfactory. Apply this fertilizer at the rate of two pounds to each one hundred square feet of garden. Commercial gardeners should know their crops and soil and fertilize according to the needs of such. This knowledge and study will prevent the wasteful use of fertilizers.

Nitrogen. The effect of nitrogen on the growth of a plant is more quickly marked than that of either of the other two elements. It has a direct influence on the development of the leafy parts of the plant and imparts a deep green colour to the leaves. In vegetables, succulence is a highly desired quality and nitrogen tends to produce this. Nitrogen, of the three elements, is most readily lost from tilled soils. It is the most expensive to buy and therefore is likely to be scantily supplied. Nitrogen-bearing fertilizers may be purchased either in the organic or inorganic forms. The inorganic nitrogen fertilizers have the nitrogen in the most readily available form for use by the plant. This type of fertilizer is used where a supply of nitrogen is desired for the immediate or fairly rapid use of the plant. The organic forms are used where a less rapid but steady supply of nitrogen is desired over a comparatively long season of growth. Hence, we would not advise the use of organic fertilizers to supply nitrogen to a crop of early tomatoes which we wished to stimulate just after the plants had been set out into the garden. In the use of nitrate of soda small applications, up to two hundred pounds per acre and repeated, are recommended rather than heavy applications. Larger quantities of sulphate of ammonia may be safely applied. In the use of the latter a soil containing plenty of lime will give best results and the fertilizer should be applied some weeks ahead of when the crop will need it.

Nitrogen Fertilizers	Per cent. of Nitrogen	Availability rating
Nitrate of Soda	15.5	100
Sulphate of Ammonia	20	86
Blood Meal (dried)	Red 13–14, Black 6–12	65–70
Tankage	4–12	60–65

Phosphorus. Phosphorus fertilizers are usually found to be valuable of application on practically all soils for growing vegetables. The role given to phosphorus in plant growth is that it hastens maturity, increases root development, especially the fibrous roots, improves the quality of the crop and increases the resistance of the plant to disease. Phosphate rock and animal bones are the chief sources of phosphorus. In the untreated state the phosphorus is only slowly available. Rock phosphate is treated with sulphuric acid and the commonly known material acid phosphate is produced. The phosphorus in this form is available to the plant. Steaming of bones aids in making available the phosphorus. However, unless the bones are treated with sulphuric acid, the phosphorus will not be in the readily available form.

Phosphorus Fertilizers	Per cent.	Availability
Rock Phosphate	20%–50%	Poor.
Acid Phosphate	16%	Good.
Bone Meal (crushed)	20% variable	Slow.
Steamed Bone Meal	22% variable	Fairly slow.
Precipitate Phosphate	26%	Good.
Ammo-phosphate	13% N. H_3–47% P_2O_5	Medium.
Basic Slag	10%–18%	Slow.

Potash. The third of the elements is essential to starch formation and in its subsequent transfer within the plant itself. Chlorophyl manufacture in all green plants requires potash and root crops particularly need potash. Sandy soils and muck soils are practically always poor in potash, while clay soils are considered rich. Under good methods of cultivation and soil management on average soils, especially where manure and green crops are used, the addition of potash, except in small quantities, is not usually profitable. Such crops as potatoes often prove the exception, however.

Potash Fertilizers	Per cent. Potash	Availability
Muriate of Potash	48%–51%	Good.
Sulphate of Potash	48%–51%	Good.
Potassium Carbonate	62%–65%	Good.
Kainite	12%–20%	Do not apply immediately preceding planting.
Wood Ashes	1%– 6%	Very good.

DETERMINING RELATIVE VALUES OF FERTILIZERS

Fertilizers may be purchased as "complete" fertilizers, that is, mixed fertilizers of guaranteed analysis bearing all three elements, nitrogen, phosphorus and potash, or they may be obtained in forms bearing the separate elements. When complete fertilizers are purchased it will rarely pay to buy one of very low analysis, since the price charged usually is relatively high to the fertilizing value and the chances are great that the material used was low grade. and of poor availability. The relative values of "complete" fertilizers may be compared both with other "complete" mixtures and with the single elements. Also, the relative values of the various materials containing the single elements may be compared.

Calculations may be made on the "unit" basis or on the basis of a pound of actual fertilizing material. A unit is one per cent. of 2,000 lbs., or 20 lbs. of actual plant food in this case. Thus a "complete" fertilizer analyzing 4-8-4 contains 4 units of nitrogen or 80 lbs.; 8 units of phosphorus or 160 lbs.; and 4 units of potash or 80 lbs.

To find the value of a unit of nitrate of soda for example, supposing the nitrate to cost $70 per ton, divide the cost by the percentage of nitrogen present in nitrate of soda, thus $70 multiplied by 1/15.5 equals $4.51, or the value of one unit of nitrogen.

The value per pound would be found as follows: Taking nitrate of soda again as being 15.5 per cent. pure, we have 15.5 lbs. of nitrogen in 100 lbs., or in one ton 15.5/100 multiplied by 2,000 equals 310 lbs., of nitrogen costing $70.00 or 70.00/310 equals 22½c. approximately as the value of one pound.

Suppose Acid Phosphate costs $28.00 per ton.
∴ 1 unit costs $28.00×1/16=$1.75 per unit.
Suppose Muriate of Potash costs $50 per ton.
∴ 1 unit costs $50.00×1/50=$1.00 per unit.
Two complete fertilizers are offered:
I analyses 4-8-4 and costs $44.00.
II analyses 1-6-1 and costs $27.00.

I.	4 units of nitrogen cost 4.51×4=	$18.04
	8 units of phosphorus cost 1.75×8=	14.00
	4 units of potash cost 1.00×4=	4.00
	Actual value of plant food.....	$36.04
II	1 unit of nitrogen costs 4.51×1=	$4.51
	1 unit of phosphorus costs 1.75×6=	10.50
	1 unit of potash costs 1.00×1=	1.00
	Actual value of plant food.....	$16.01

In the case of II there is shown to be a spread of $11.00 between the actual value of the plant food and the cost price, while in I there exists only a spread of $8.00 to cover cost of sacks, mixing and bagging. It is easily seen that, though the actual price asked per ton varies by $17.00, the higher priced fertilizer is the more valuable, measured in terms of plant food.

Lime. Though not a direct fertilizer, lime is an agent of fertility. Garden soils after years of working and heavy manure applications often become sour and acid. This is a bad condition for crop growing and should be corrected by liming. Lime in some form or other might be recommended as a regular application at least every five years for garden soils. Ground rock limestone is the slowest acting form to apply, but the most lasting in its effects. Hydrated lime is quick acting and more care must be used in its use. Of the former, one to two tons per acre is often used. With the latter, 1,000 lbs. to 1,500 lbs. per acre is used. Lime is best applied in the fall before a spring crop is to be grown. Some crops should not directly follow lime, such as potatoes, since scab is more readily developed. Lime plays a part in helping to control such diseases as club root of cabbage.

Green Manures and Cover Crops. By turning under green manuring crops supplemented by the wise use of commercial fertilizers, it is possible to keep up the fertility of soils for growing vegetables crops where little manure is to be had. Green manures and cover crops, however, can be used to good advantage under all systems of garden soil management.

An abundance of humus is an essential in soils for vegetable growing. Except in muck soils this can only be supplied through the use of manure or soil-improving crops. Without an abundance of humus being present, the use of large quantities of commercial fertilizer year after year is not warranted. Other effects that green manures have are: (1) In the case of the leguminous crops nitrogen is added. (2) Soluble plant food is taken up and prevented from leaching away. (3) Mineral nutrients are brought from below to the top soil. (4) Favourable conditions are brought about for bacterial life in soil. (5) The subsoil condition is improved. (6) With the increase of humus, light soils hold moisture to a greater extent.

Green manures and cover crops may be divided into—Legumes and Non-legumes.

Legumes. Leguminous crops are those which, like the clovers, are able to gather free nitrogen from the air and store it on their roots. This nitrogen becomes available for the succeeding crop. Alfalfa, red clover, mammoth

clover, sweet clover, hairy vetch, soy beans and peas. Of the above, hairy vetch and peas are probably the most used for short season crops under our climatic conditions, though the others all may be used, especially where a suitable rotation of crops is followed on a large area of land. Vetch, if sown alone, should be sown not later than early August and at the rate of sixty to eighty pounds per acre. With rye, twenty pounds per acre is sufficient. Vetch will winter over, while peas are usually sown with oats and turned under in the fall.

Non-legumes. Of this group rye is the most popular because of its general adaptability. It may be planted quite late and will winter over well as a cover crop. By careful planning of the cropping system it is possible to work rye over nearly all of the soil each season. It should be sown at the rate of from two and one-half to three bushels per acre, when used alone, and one and one-half bushels per acre when used with vetch. Other non-legumes used are oats, buckwheat and rape, none of which will winter over and should be plowed under while green.

Plowing Under Green Manure Crops. The time to do this depends upon several factors: kind of soil, season of year, weather conditions and crops to follow. Where the crop is turned under in the fall it should be left as late as necessary to get maximum growth. For early vegetables, if left till spring, the crop should be turned under as early as possible. With such crops as rye, to be followed by a vegetable crop, do not allow the straw to become woody, especially so if dry weather is likely to follow.

SEED

Good seed is as much an essential in successful vegetable growing as is any other factor. Poor seed and poor crops go hand in hand. The initial expense of first class, reliable seed is comparatively very small. Good seed should germinate well, be free from weed seeds, be true to name and not mixed, be free from diseases and produce a good type of product according to the variety represented. Purchase seed only from reliable seedsmen who have an established business. It is often advisable to buy seed a year in advance of when needed so that a small amount may be tested during the current year. Simple germination tests of seed may be made by means of a piece of blotting paper, a plate or dish and a cover. Count out a certain number of seeds, place them on the moistened paper, which is kept moist in the dish, cover over and keep in a warm room.

As will be seen in the corresponding table, seeds if kept under proper conditions will keep for varying lengths of time, according to variety, and still preserve their germinability. Good average room temperature, not too dry or too moist, is all that is required. Seeds need a certain amount of air in storage.

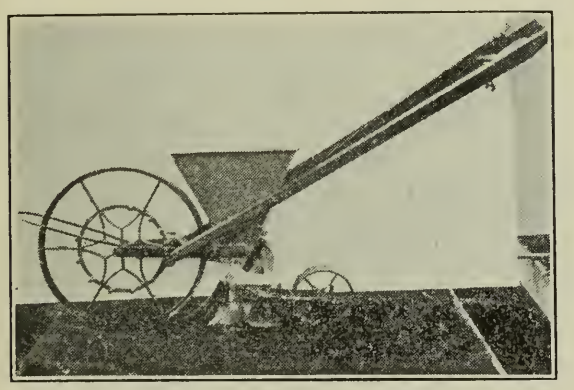
LENGTH OF TIME SEEDS MAY BE EXPECTED TO RETAIN THEIR VITALITY WHEN PROPERLY HANDLED

Vegetable	Years	Vegetable	Years	Vegetable	Years
Asparagus	3	Kale	4	Pumpkin	4
Bean	3	Lettuce	5	Radish	4
Beet	4	Muskmelon	5	Salsify	1
Cabbage	4	Okra	3	Spinach	4
Carrot	2	Onion	2	Squash	4
Cauliflower	4	Parsley	1	Sweet Corn	2
Celery	3	Parsnip	1	Tomato	3
Cucumber	5	Peas	2	Turnip	4
Eggplant	5	Pepper	2	Watermelon	5

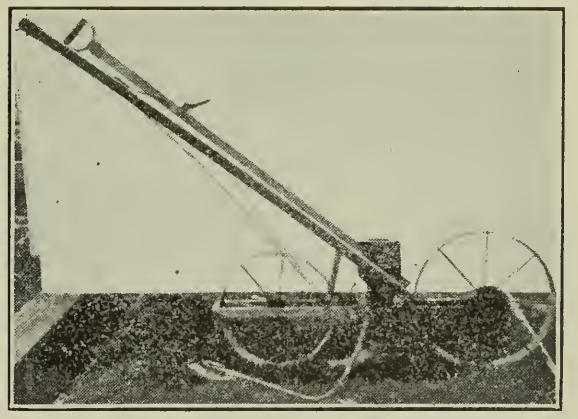
SEED SOWING

In the general table will be found condensed information concerning planting dates and depths to sow seed. This information should serve as a guide.

When sowing seed the method used will largely depend upon the area of the garden and the nature of the enterprise. For the small backyard garden, seed is usually sown by hand either by sprinkling seed from the corner of the packet or by taking it up between the first two fingers and by means of a rubbing motion placing it uniformly in the row. A shallow trench is usually made with some handy implement and after the seed is sown this should be lightly covered and firmed down. Firming is especially needed in dry soils. The proper use of the feet for this purpose is hard to improve on. Larger scale growers find the use of a modern seed drill necessary to sow quantities of seed and better work can be done by a good operator skilled in the use of such a machine than can be done by hand sowing.



A fertilizer drill which may be used to either drill in or broadcast fertilizer



A common type of seed drill

Straight rows are very desirable in all gardens and make for greater efficiency in cultivation as well as improving the appearance of the garden. As a general rule, seed is sown much more thickly than the plants should stand. This means that, as soon as possible after the plants are up, they should be thinned so as to give each a fair chance to grow and develop normally. Expert gardeners, who are sure of their seed and who have properly prepared their soil, are able to cut down on the quantity of seed used so that often very little thinning is required. This is better for the remaining plants.

GROWING PLANTS

It is necessary to start growing the plants of many of our vegetable crops under conditions of artificial heat or in seed beds. This is due to the nature of some and, in other cases, because we desire to have certain crops ready for use early in the season. For the small city gardener it may be best to buy such plants ready for setting out into the garden. Only good, strong, sturdy plants should be secured and of the variety desired. However, plants may be grown in limited quantities in the house, using boxes placed in windows or in a sun room or conservatory.

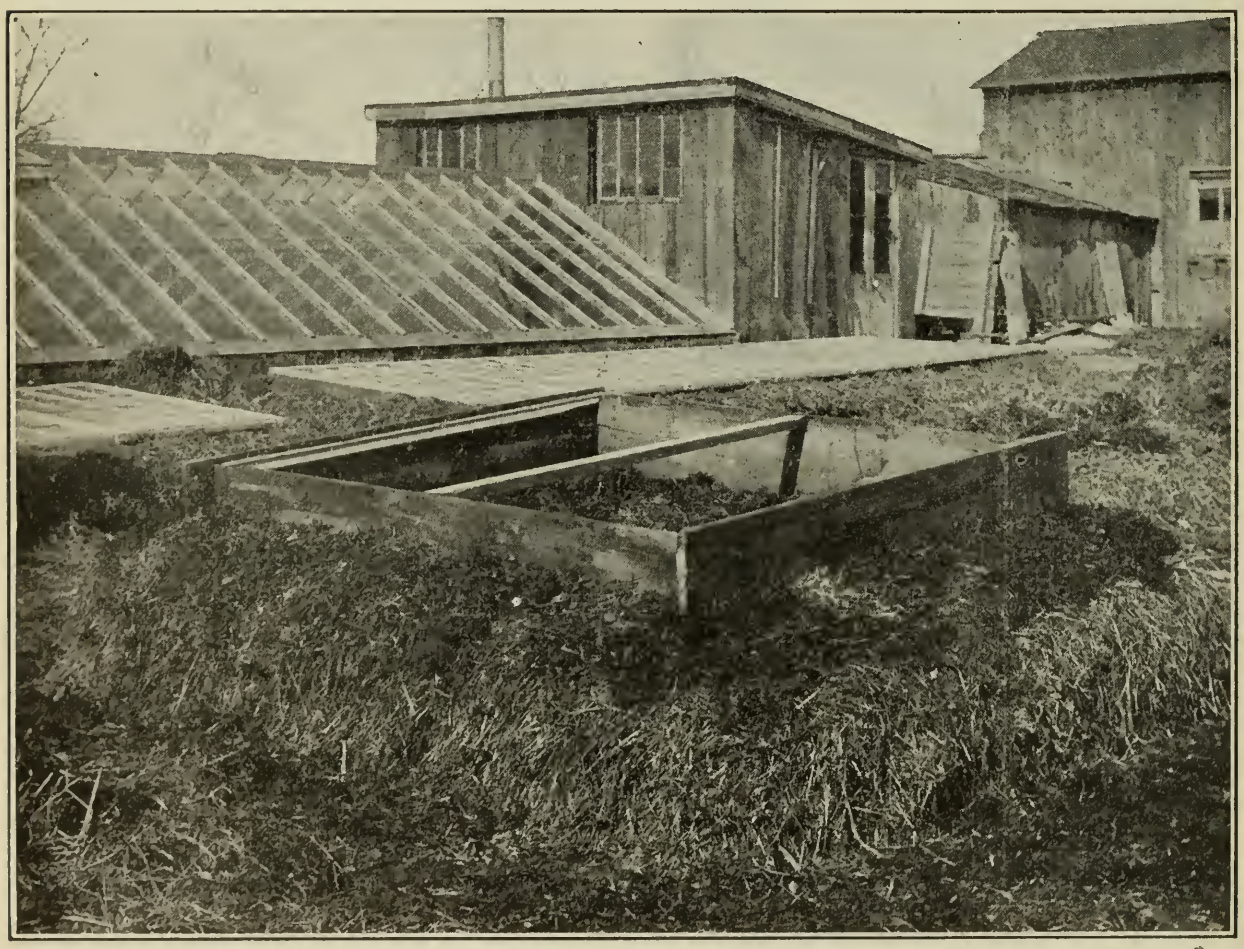
When boxes are used they may be of any convenent size and from two and a half to three inches deep, provided with drainage holes. The soil used should be a good friable loam with a large proportion of sand. Coarse material is put on the bottom and the box is filled to within about half an inch of the top. The

corners should be well firmed and the top smoothed and levelled. Shallow drills about two inches apart are made and the seed is carefully sown, not too thickly. For small seeds, such as celery, it is advisable to sift a light covering of sand over the top to cover them. The boxes are then thoroughly watered, care being taken not to disturb the seed, and set in a bright, sunny place. Further watering should only be given when needed and the boxes must be turned round frequently if in windows. For the best plants to be obtained the seedlings should be thinned out or transplanted so that they are never crowded.

Depths to plant:—Tomato, ⅛-inch to ¼-inch; Onion, ¼-inch; Cabbage and Cauliflower, ¼-inch; Lettuce, ⅛-inch; Celery, barely mark the drill and cover lightly with sand.

HOTBEDS

Although during later years greenhouses have become more generally used, hotbeds are still extensively employed wherever it is necessary to start early plants. A hotbed is simply an inexpensive forcer, which can be erected by

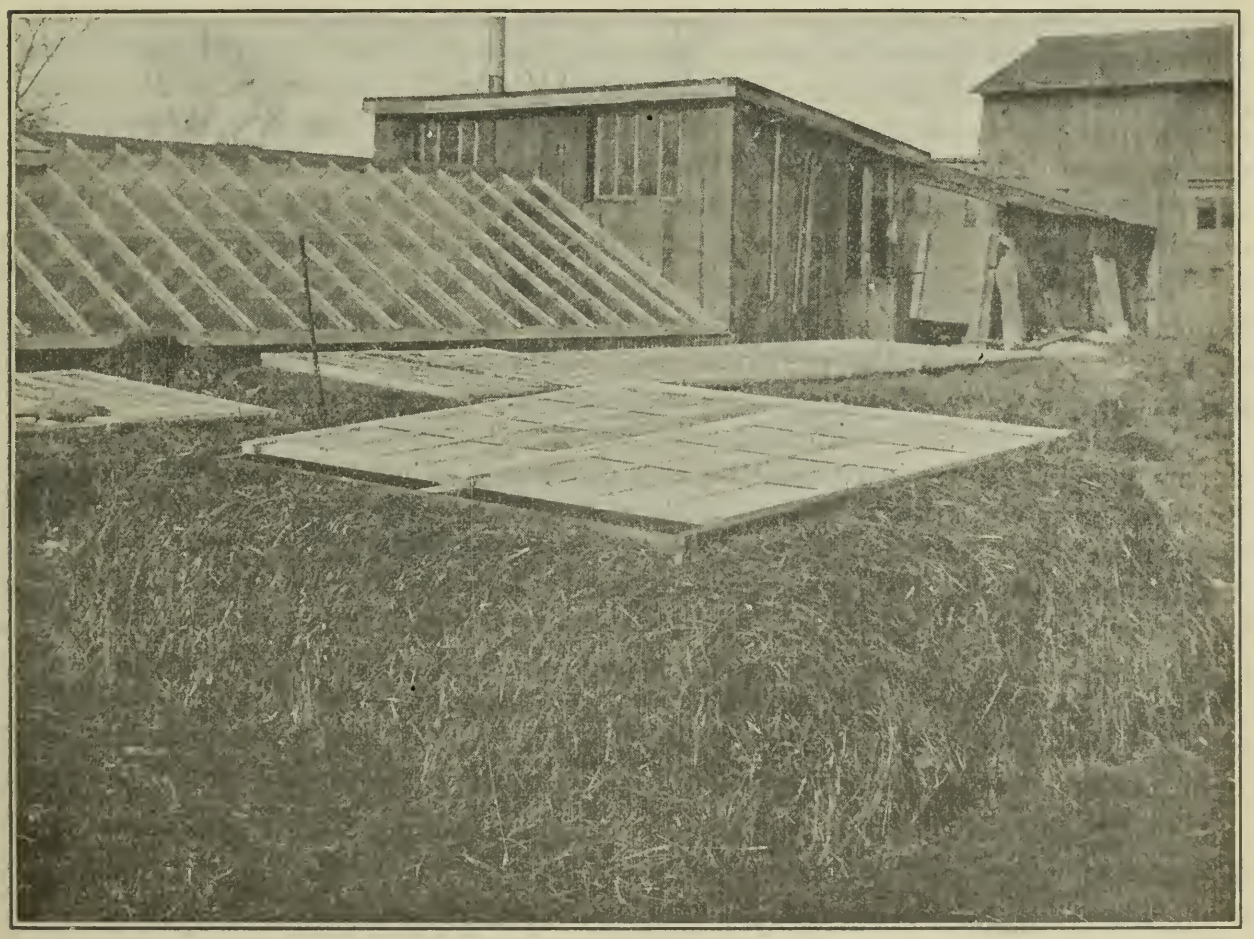


Hotbed, showing arrangement of manure and frame. One wagon load of manure was used. Any backyard gardener could make one of these and grow many plants.

anyone. Many farmers annually lay down a hotbed, quite a number of city gardeners use them, and most vegetable growers depend on them for probably 50 per cent. of their outdoor crop. Seed can be sown in the hotbed before the snow is off the ground, and the plants will have from four to six weeks' start when warm weather comes in the spring. By this means the vegetable grower has that much start on the crop grown from seed. This means early marketing,

which every grower is seeking for, because of the increase in returns. Some crops can be grown to maturity in our climate only by the use of the hotbed.

Location.—Hotbeds should be placed in a warm position, close to the house or greenhouse. First and foremost, they must be handy, for considerable attention is required to handle a hotbed successfully. They should be set facing the south if possible, and should be sheltered from severe winds by buildings or windbreaks, either natural or artificial. On vegetable gardens, where perhaps 100 beds are made, the rows should be parallel and should be such a distance apart that the plants can be conveniently handled. Some growers have them three feet apart and others ten feet. They should be located close to a ready supply of water, for large quantities are required at all seasons.



Hotbed, completed, showing arrangement of manure around frame, and also the sash slightly open to ventilate.

Construction.—Ninety per cent. of the hotbeds in Ontario are heated by the fermentation of horse manure. Some are heated by steam-pipe extensions from greenhouses. Both methods are good, but the manure method is more in general use than the steam pipe.

The standard size of a hotbed sash is three feet by six feet, although it is not absolutely necessary to secure this size. Any ordinary window will give good service. A frame must be built to support this window. One inch lumber is usually used, and the frame is so constructed that there is a fall of one inch for every foot of length of the frame. From this there is sufficient slope to catch all the rays of the sun, and to run off rain or moisture which collects on the glass. The depths of the sides and ends should be approximately, for a standard hot-

bed, eighteen inches at high end and twelve at low end. Two-light hotbeds are made by simply doubling the length of the frame and midway putting in a three-inch piece to support the sash in the centre.

How to Make a Hotbed.—Secure a quantity of fresh horse manure that has been stored a few days, so that it will ferment readily. Turn this over twice to thoroughly mix it. Pile this manure on the south side of a house, barn or high, tight board fence, to break the force of the wind. Pile to a depth of eighteen inches or two feet, and tramp down thoroughly as each six inches is added. Set the frame on this. Put in four to six inches of soil and then place the sash or window on the top of frame. Manure should then be piled around the frame on all sides up to the top. This keeps the sides, as well as the bottom, supplied with plenty of heat. The bed should then be allowed to stand for four days to allow all noxious gases to come away from the manure. Lifting the glass a couple of inches for several hours a day will allow the escape of these gases. After the fourth day the soil should be raked down level, all sticks, stones and pieces of straw removed and then planting can commence. The temperature should be between eighty and ninety degrees. In some instances with the manure hotbed the manure fails to heat. This can be remedied by opening a hole in the manure and throwing in a pail of boiling water.

When manure is scarce, a pit may be dug in soil having good drainage, to a depth of sixteen to eighteen inches and filled with fresh manure. The frame is then set on this, as in the previous case. This method is used largely by men who lay down several hundred beds each spring, and it gives entire satisfaction.

Vegetable growers who annually lay down many hotbeds haul manure during the fall and winter months and cover the ground in the hotbed yard. This prevents the ground from becoming frozen, and as the season for hotbed-making comes this manure is replaced by fresh manure, which forms the heater of the bed. In this way it is not necessary to have so much manure under the frame, ten or twelve inches will be sufficient in this method.

Steam or hot water hotbeds do not require manure under the frame, only around the sides. A flow and return pipe placed at the ends of the frame inside will give sufficient heat. To use a steam-heated hotbed the yard must be close to the greenhouse, and the pipe should run through a continuous row of frames.

Care of Hotbed.—As a hotbed is used during severe weather it can be understood that considerable attention is required. Watering and ventilating must be most carefully attended to, and only by this care daily can good plants be grown.

Watering.—Water sparingly in the early part of the season, and only on bright days. It is advisable to water with a can which throws a fine spray, only when the plants really require it, and then in the morning. This time is recommended because the plants will have time to dry off before evening, and thus avoid diseases which come through leaving a moist atmosphere in the bed over night. Some growers who do not use many hotbeds recommend slightly warm water. On a large scale this is not followed, ordinary cold water only being used.

Ventilation.—Probably this end of the management of a hotbed is one requiring the most care and attention. The hotbeds are ventilated by supporting one end of the sash on a small block of wood or by raising the whole side of a sash and blocking it up or by supporting it on the side of the next sash to it. The side or end facing the wind should never be opened. As the season advances the sash are sometimes drawn partly off the frame, and as the warm weather comes the sash is taken off entirely during the day.

Time to Ventilate.—Hotbeds should be ventilated every day, some days more than others. On a stormy day it would be out of the question to ventilate very much, but a lath under the sask will give a good circulation of air. On a bright, sunshiny day the sash can be raised up as much as two inches. They should be opened in the morning when the sun becomes somewhat warm and can be left until the afternoon when it begins to get cool again. It should be seen to that the sashes are replaced before night. The question of how long the sashes should be left open must be determined by experience. A thorough circulation of air is essential, but too much cold air will give the plants a check, and in all probability ruin the crop. Always ventilate after watering to prevent scalding the tender plants.

Planting in a Hotbed.—After the soil has been thoroughly prepared by raking down and all straws and other refuse removed, the seeds should be planted. Rows three inches apart and having a depth of one-quarter inch are made by gently pressing a lath into the soil. The seeds can be sown by hand and then barely covered with soil by simply drawing the soil back again with the lath.

Care of Plants.—It will be necessary to pull out all weeds as soon as they are seen and they will appear before the vegetable plants. As the plants grow they should be watered occasionally and given plenty of ventilation. Later on, if they commence to crowd in the row, they can be thinned out as necessary. Stirring the soil several times during the growth with the fingers or a hand weeder will be found a good practice.

Sorts to Grow.—A hotbed will give a good supply of lettuce, radish, beets and carrots before they can be had from seed sown outdoors. Lettuce and radish can be grown in the same row. Green onions can be secured by planting small onions close together in the row. Young tomato, cabbage celery, onion, cauliflower and many other plants can be started in the hotbed. These will be far in advance of those grown from seed out of doors, as far as earliness is concerned.

The spent hotbed may be used to grow muskmelons. A few seeds may be planted at each end of the bed in the soil, and by keeping the sash on during the night until warm weather comes a good crop of melons of excellent flavour can be secured.

COLD FRAMES

A cold frame is merely a part of the garden covered with a sash supported on a wooden frame. A cold frame has no bottom heat or any other heat excepting that received from the sun; and otherwise it is the same as a hotbed. The cold frame is used to protect tender growing plants from cold weather. It prevents strong winds from disturbing the plants and protects the plants from severe changes of the weather. It is used more as a middle or hardening stage for the plant before it is taken to the field. It hardens off the plants so that they can stand any ordinary change in the weather which may come after transplanting time. Cold frames are also used along in the season to start young plants, particularly cabbage and cauliflower plants.

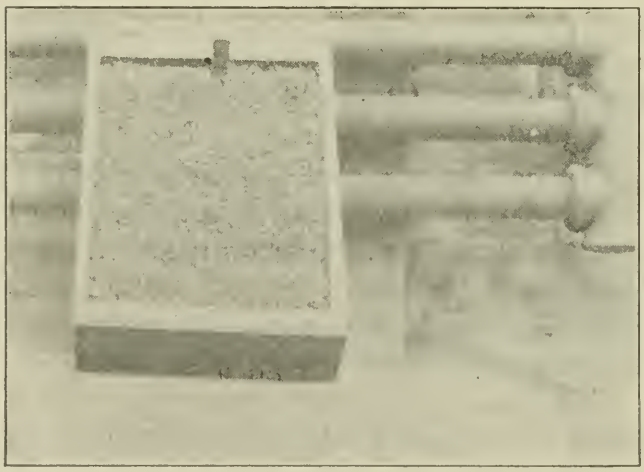
Cold frames are usually placed near the greenhouse or in a sheltered position. In some cases the frames are made in the field where the plants are to remain, and the frame is removed as the season advances, leaving the plant in its permanent position. They can be protected in severe weather by means of banking up the sides of the frame with earth or manure. Straw or mats may be spread over the sash on cold nights. As the warm weather comes the sash may be replaced

by frames covered with cotton. These should be the same size as the sash and should be used as a covering for the plants on cool nights. The cotton will permit a free circulation of air and yet will not allow the temperature to go down too low to damage the plants.

MANAGEMENT.—The soil in the cold frame should be a good garden soil of fairly light texture. Many growers transfer the flats with the plants in them from the hotbed to the cold frame, thus doing away with securing soil for the cold frame. Water should be given frequently to keep the plants growing. Ventilation must be looked after carefully.

TRANSPLANTING TO THE GARDEN

In order to obtain good results the plants used should be stocky, well-grown, and well-hardened if they are to withstand their new conditions. The soil should be in a thorough state of preparation before transplanting commences and, if possible, fairly moist. Plants should be lifted from the seed bed carefully, preserving as much of the fine root system as is possible. Transplanting is best



A box of healthy celery seedlings ready to transplant.

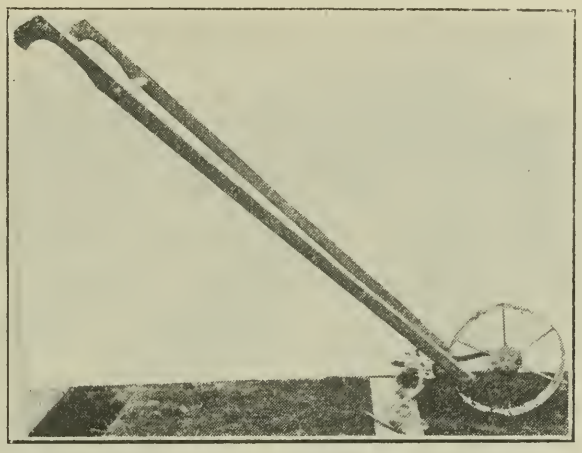
done just before or after a rain, or on a dull, cloudy day. If the weather is dry and hot, postpone the work until late afternoon and water the plants, if possible. Set the roots down into the soil a little deeper than they were previously, depending on the plant in question and firm the soil well around the plant. Leave the surface of the soil loose and mulched after finishing the job.

CULTIVATION

The main reason why cultivation is necessary with garden crops is in order to keep down weeds which, if allowed to grow, would compete very seriously with the crop plants for food and moisture, particularly the latter. Cultivation also prevents the formation of a surface crust and if properly carried out preserves a dust mulch which helps to conserve moisture by preventing evaporation. Cultivation, to be most beneficial, should be timely and thorough. Many gardeners cultivate after every rain when possible. Weeds can be best controlled by cultivation most at the time when they are breaking through the ground and before they have taken root firmly. It is usually well to cultivate deeply early in the season, so long as the cultivator teeth do not go too close to the plants, but as the season advances cultivation should gradually become more shallow

and finally when the plants roots are being injured should cease. Many of our garden crops send their root systems right across the space between the rows.

For the backyard garden the most useful tools are the hoe and the rake. Two hoes should be provided, one wide and the other narrow. The hand-weeder and claw-weeder are also useful. Where a garden is of any size at all



One type of wheel hoe for use with garden crops

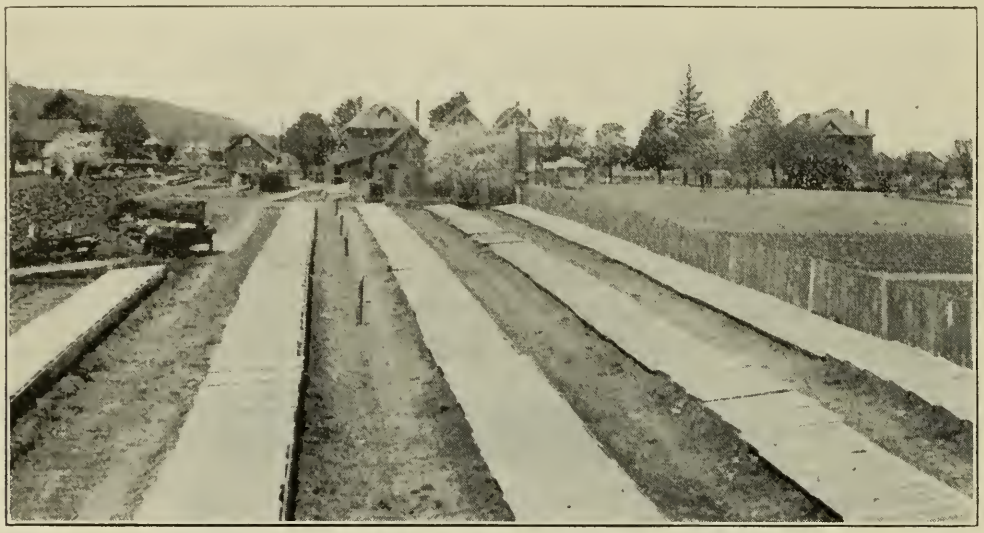
one of the several makes of hand cultivators or wheel-hoes is recommended. Various attachments for these are obtainable and excellent work can be rapidly and easily accomplished. For market gardeners the horse-drawn cultivators will be found to be essential as well as the wheel hoes, and at least two sets of teeth for such should be provided, one for deep working and the other for shallow cultivation and weed cutting.

IRRIGATION

Vegetable crops are to a large extent grown on high-priced land. It is essential that each crop make its maximum returns in order to prove profitable. This cannot be assured without having some control over moisture conditions which affect the crops. Continuous growth is essential to high quality, and without the use of artificial watering this cannot be assured. Irrigation is a

Overhead irrigation in the frame-yard.

necessity in the growing of some special crops such as celery on upland soil. It is often of special value just after seeds are planted or at transplanting time, and it may prove the means of saving a crop from drought or frost. Amongst Ontario vegetable growers there are several methods of irrigation in use.



Frames such as these may be used for hardening plants before transplanting or for growing an early crop.

Sub-irrigation.—This method is not practicable for outdoor use unless under exceptional circumstances. There is one large grower of onions who practises this system, pumping the water back into his tile-drain system from the large irrigation ditches.

Surface Irrigation.—This method is practised to a very limited extent where peculiar circumstances favour it. A large supply of available water is needed along with a favourable slope of the land. Tile drainage is also essential on the heavier soils.

An overhead irrigation system swung high on cables.

Overhead Spray Irrigation.—The method in most popular use in Ontario and elsewhere is that in which water is applied to the surface of soils as a spray or mist. The water is applied in gardens by means of elevated pipes fitted with

special nozzles at intervals, through which the water is forced, breaking into a fine mist before falling to the ground. About 3,600 gallons per acre per hour is the amount used and best results are obtained with a pressure of from thirty to fifty pounds.

Advantages.—(1) Washing of the soil is eliminated. (2) Uniform water distribution results. (3) Economy of water is effected. (4) Operates on any kind of land. (5) Requires the minimum of labour to operate. (6) Watering can be done at any time of the day. (7) Crops are hastened toward maturity. (8) Quality of crops is increased.

Costs.—Such a system costs considerable to install and the yearly charges against it must be made up by the advantages gained. Experience has shown many gardeners, however, that it is a fairly cheap form of crop insurance. The following figures are given by a reliable vegetable grower who has had several years' experience in the use of such a system.

Cost of complete outfit to water one acre, exclusive of the pumping outfit—$300 to $400 per acre.

Cost of pumping plant sufficient for five acres, with a fairly handy water supply—$500, or $100 per acre.

Total initial cost per acre—$500.

Interest and depreciation at 15 per cent. on $500—$75.00.

Yearly charge per acre—$75.00.

An overhead system on pipe supports.

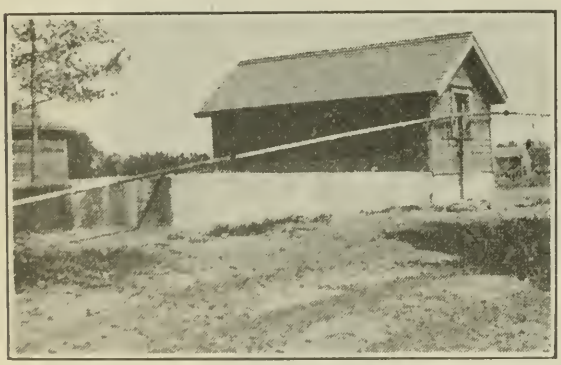
Points on Installing an Overhead System:

1. Plan it to suit your particular needs.
2. Run nozzle lines in direction of cultivation.
3. Regulate distance apart of lines forty-five feet to fifty-five feet by amount of pressure available in water supply.
4. Tall posts about six feet from the ground are more popularly used to set up lines on than short posts or suspended cables.
5. Plan to use the minimum amount of large pipe, so long as efficiency is maintained.
6. Length of nozzle lines regulates size of pipe used. Connecting end must be large enough to carry full head from feed pipe. Three-quarter-inch pipe is sufficient at far end of nozzle lines.
7. Long distance pumping directly into nozzle lines requires longer mains and more power than where a handy reservoir is used to pump from.
8. Provide flush valves or caps at far ends of lines.

9. Automatic turning devices are useful, but cost extra. Hand-turning levers and rollers for the support posts should be supplied, at least.
10. If wooden support posts are used, paint the portion which goes into the ground and six inches above.
11. Carefully level and line up support posts.
12. Nozzle line pipes should be of galvanized material.
13. Provide a cut-off valve for all lines.
14. In planning a pumping system, provide one large enough to take care of future expansion of the irrigation system.
15. Unless previously experienced, obtain the advice of experts on irrigation engineering; there are firms who specialize in furnishing irrigation systems.

SOIL STERILIZATION

In growing plants under glass, conditions arise which make for the development of fungus diseases and other pests which may exist in the soil used in the seed or plant beds. Each year large losses are incurred by vegetable growers as a result of young plants dying off or of the plants not growing thriftily. The trouble is largely due to fungus diseases attacking the plants or in some cases to the attacks of nematode worms on the roots. These pests are mostly carried in the soil and only await favourable conditions to develop. Various methods of soil sterilization are advocated for treating diseased soil which is to be used for seed or plant beds.



Supply tank and pump house for an overhead irrigation system

The pan method of steam sterilization. Note the sacking covering over and around the outfit

Boiling Water.—Saturating the soil with boiling water and keeping it so as to maintain the heat for some time afterward is one method. This treatment has its limitations and is only effective under the best of conditions with the average growers' equipment.

Formalin.—Soil is saturated with a solution of from three to four pints of forty per cent. formalin to forty gallons of water. One gallon of solution is used to each square foot of soil. After treatment it is a good practice to cover the soil with some old sacking for a few days. Do not attempt to plant anything in the soil for about nine or ten days following treatment. The formalin treatment is only effective against fungus diseases.

Steam.—The most common and probably the most reliable method of soil sterilization under most conditions is carried out by the use of steam. Green-

house growers and hotbed owners both find it generally the most satisfactory, as steam sterilization, when properly carried out, controls both fungus diseases and nematode. The treatment also seems to benefit the soil and improve conditions favourable to the growth of subsequent crops.

The most popular method is the use of the inverted pan. The pan is a large galvanized one, six by ten feet wide and about six inches deep, fitted with an opening for the steam pipe and a pipe for diffusing the steam. It is pressed down into the soil and weighted above. Steam applied at a pressure of thirty pounds for one-half hour should give good results. Some growers judge the time necessary by placing a few potatoes on the soil and when the potatoes are cooked they remove the pan. Soil to be used for seed or plant beds or for potting is sometimes treated in a chamber into which live steam is forced. This is a good way for handling limited quantities of soil.

VEGETABLE STORAGE

Storage offers advantages to both the home and commercial gardener. To the former it increases his garden efficiency by a period of three or four months. To the commercial man storage is a means of increasing his business to a considerable extent. He is able to hold over, past the period of glutted markets in the fall, large amounts of many crops which he can dispose of profitably throughout the winter. Further than this he can maintain a contact with his customers throughout the year and he has his revenue more evenly distributed through these later sales.

Storage Principles:

1. A good quality, sound, not over-ripe product free from disease or mechanical injury is necessary.
2. The proper temperature and moisture requirements for the particular product to be maintained uniformly at all times.
3. Release of stagnant air and the circulation of fresh air—proper ventilation.

Crop Requirements:

1. Low temperature and fairly moist atmosphere. Temperature 31° F. to 35° F. Beets, carrots, cabbage and cauliflower (medium moisture), celery, horse radish, leek, parsnip, potato, salsify, turnips.
2. Low temperature and a dry atmosphere. Temperature 32° F. to 35° F. Onions, garlic.
3. High temperature and a dry atmosphere. Temperature 48° F. to 56° F. Peppers (medium dry), pumpkins, squash, sweet potatoes.

For the home gardener a part of the dwelling house cellar, partitioned off and provided with a means of fresh air ventilation is probably the most satisfactory storage room. The market gardener may make use of this form of storage, of special cellars, of above-ground storage buildings or of outside storage pits built in well-drained locations.

The root crops and cabbage can be stored in cellars or pits. The above ground storage is suited to such crops as onions, cauliflower and celery. The root crops, when stored in small quantities, are kept in good condition by packing in slightly moist sand. Celery, with the roots on, is packed around the bottom with moist soil. Cabbage may be lifted, roots left on and planted again in soil in the cellar. An attic or spare room is useful for storing squash and pumpkins.

ASPARAGUS

Asparagus is one of the finest and most appetizing products of the garden. Coming into use, as it does, early in the spring, it is among the first of the fresh vegetables offered from the home garden. It is also a crop of great importance to the market gardener and truck grower. Not only is the production of asparagus tips for immediate consumption of great importance, but each year large quantities are canned as well. Asparagus retains its flavour when canned better than any other vegetable, and its use as a canned product is gaining in popularity.

Asparagus beds when once established will continue to produce for many years, the length of time depending upon the profitableness of the crop produced. Ten years for a commercial plantation is usually considered satisfactory. During the last few years the commercial acreage of asparagus in Ontario has been very largely increased, but there is still room for a lot wider planting of this delicious vegetable in home gardens, particularly in farm home gardens.

Soil. Although asparagus may be grown on most kinds of soil a preference is shown for soils of a deep, loose nature such as we find in our sandy and sandy loam soils. These types of soil also give an advantage in favour of earliness and being naturally well-drained, provide another favourable feature. Soil for an asparagus plantation should be well prepared beforehand. Deep plowing and even subsoiling are often necessary to give a depth of ten to twelve inches of loose soil in a bed. Before planting the soil should be thoroughly pulverized.

Manures and Fertilizers.—This crop, being a fairly heavy feeder and being frequently grown on relatively poor soils, requires liberal fertilizing. Many growers use both manure and chemical fertilizers in liberal quantities. Manure, by some growers, is considered essential; however, experimental results obtained in Massachusetts do not justify this belief. The above results showed that on sandy soils moderate applications of chemical fertilizers give as good yields as manure alone, or a combination of manure and commercial fertilizers. The same experimenters found that the seasonal cut of asparagus did not appear to be affected by the early application of nitrate of soda to any great extent. However, they found that if part of the nitrate of soda was applied after cutting season it did tend to decrease the susceptibility of the plants to disease.

Growers who have chicken manure available often use it on their asparagus. If stable manure is scarce or needed elsewhere the application of a high-grade, complete fertilizer analyzing four to six per cent. nitrogen, six to eight per cent. phosphoric acid and four to eight per cent. potash (muriate) at the rate of eight hundred to twelve hundred pounds per acre, should give good results. A light application of nitrate of soda, one hundred and fifty pounds per acre, is still recommended for early use, the balance of the fertilizer to be applied near the end of or right after cutting season. Care should be taken in applying fertilizer that no injury is done to the shoots.

Salt. Many growers still consider salt to be an essential to success in asparagus culture, but modern experimental evidence goes to show that it has little or no effect. Especially is this so if muriate of potash is used. In order for salt to be useful as a weed killer, it must be used in excessively large quantities, and the results do not justify the expense of its use.

Plants and Planting.—The best plants to set out are one-year-old plants or crowns. They should be strong, sturdy, well-grown crowns with five or six strong buds rather than a number of weaker buds. These crowns may be obtained from the various nursery or seedsmen growers or may be grown by the gardener himself.

Seed is planted early in the spring in a well-prepared seed bed, rich in food material. Drills fifteen to eighteen inches apart are used where hand cultivation is to be given and the seed is covered to a depth of about three-quarters inch. Germination is very slow and soaking the seed may help, also by sowing a few seeds of some quick-growing crop along with the asparagus, the rows will be marked early. After the plants are up they should be thinned out to stand four or five inches apart in the row. Frequent cultivations are desirable throughout the growing season, and weeds should be kept down.

It is customary to lift the roots late in the fall and store over winter in some cool place, covering the roots with moist sand. Before planting the crowns should be gone over and, if possible, all weak and poorly grown ones discarded. Crowns are set from six to twelve inches deep. The shallower planting may give a slightly earlier crop, but a shorter-lived plantation. From eight to ten inches is a good depth to plant under general conditions. After the soil has been thoroughly prepared, V-shaped furrows are struck out at about five feet apart and to the required depth.

A field ready for receiving asparagus crowns.

The plants are set at the bottom of these furrows on little mounds of earth, so that the roots are well spread out. Plants are spaced from eighteen to thirty inches apart for very rich soil. About two or three inches of soil is covered over the crowns, the rest of the furrow being filled in gradually throughout the summer by subsequent cultivations. Twenty-five feet of row should prove sufficient to supply the average family.

Cultivation and Care.—Some early hoe crops, such as cabbage or lettuce, may be grown between the rows during the first season. However, nothing that will interfere with the growth of the asparagus plants or the necessary cultivation in keeping down weeds should be grown. Following the first season, the asparagus bed should be thoroughly disked and harrowed each spring. The only precaution necessary is to avoid injury to the crowns of the plants. Cultivation and hoeing are necessary each season to keep down weeds. A strong, healthy growth of top is desired after the cutting season is over. The foliage is necessary to the manufacture of food which is stored in the roots and from which the next year's crop will draw its sustenance. For this reason tops are left on all during the summer at least. Many growers leave the tops on all winter as protection in that they better hold the snow. On the other hand, if stalks have been diseased or insect infested they should be cut off in the fall and burned.

Harvesting.—The young shoots should not be cut from an asparagus bed during the first two years and, in the third year, if cut at all, the season of cutting should be short. In a well-established bed the cutting season may last from six to eight weeks. Harvesting, once started, is usually done every day when normal weather exists. Special knives which will cut the shoots with a downward stroke are used. An inch or two below the surface the shoot is cut, care being taken not to injure the crown or other near-by shoots not yet up. To do this the knife should be inserted straight down along the side of the shoot and then tilted.

Marketing.—Shoots should be removed to shade as quickly as possible and if to be kept placed in water, butts down. Washing is usually desirable in obtaining an attractive product. The sooner after cutting asparagus is used, the better the flavour.

The stalks should be graded into two or three grades, preferably according to size, length and general appearance. "Fancy" grade is made from large, straight stalks of good length and free from injury. No. 1 grade would be of medium size, straight and fairly long stalks. The other grade would include any marketable stalks which did not come within the above two grades. Bunches are made to suit the market, one pound being suitable size. The bunches are neatly tied top and bottom, coloured tape being an attractive material to use, and the butts are cut off evenly. For shipping, various types of boxes and baskets are used, some of which are very poor and spoil the appearance and market value of the product. A neat, light box, holding a dozen to two dozen bunches, permitting a view of the asparagus attractively packed is a great aid in selling the product.

BEANS

There are many different sorts of beans grown in gardens, but the one which does best under our Ontario climatic conditions and is most popularly grown is the kidney bean or common bean (*P. vulgaris*). This type is grown to produce for market snap beans, green shell beans and dry beans.

Soil.—For early snap beans a sandy loam is preferred; for later season crops a heavier soil is desired, as well as for the production of dry beans. Too rich soil gives too much vine growth and very heavy, poorly drained soils are not desirable.

Fertilizers.—In general phosphorus and potash are most needed by this crop. For an early crop of garden beans on light soils a readily available nitrogen fertilizer is of considerable value, so that on fairly poor sandy loams 800 pounds of a high grade 5-10-5 or 4–8–4 fertilizer would be suitable. Where manure is used in the crop rotation three hundred to four hundred pounds of acid phosphate alone should prove profitable.

Planting.—Beans are frost tender and are not usually planted till danger of frosts is over, though chances are often taken with the early crop. For garden crops the seed is usually planted by hand in rows two feet to three feet apart. The beans are spaced six inches apart and lightly but firmly covered with soil.

Cultivation.—Cultivate sufficiently to keep down the weeds until the plants are full grown. Shallow cultivation should be practised and never when the vines are wet, as disease spores are spread at this time.

Harvesting and Marketing.—Hand picking is the method of harvesting snap beans. Beans for market should be clean and free from disease or injury. They are usually shipped in eleven-quart baskets or sometimes in larger hampers.

BEETS

Beets are one of the most commonly grown vegetables both in home gardens and by market gardeners. For very early crops the seed may be sown indoors and the young plants later transplanted to the garden. The seed can be sown out-of-doors among the first of the vegetable crops as the young plants are fairly hardy and can withstand light frosts. For the late crop, to be stored over winter, a better quality beet is obtained if the seed is sown later in the season, from June on to the end of July.

Soils.—Beets are grown successfully on most types of garden soils but, commercially, sandy loams are favoured for the early crops and soils of a deeper, richer nature are preferred for the late crop. A soil containing plenty of humus, ensuring a good supply of moisture is desirable. The beets will be of better shape and appearance if grown in a loose, friable soil.

Manures and Fertilizers.—Manure is desirable, especially on sandy soils, to keep up the humus content of the soil. However, if fresh manure is used it is best applied with a previous crop such as cabbage, grown the same season. The best results, under favourable conditions, for beets may be expected from the use of a combination of manure and fertilizer. From twelve to twenty tons of manure applied with the previous crop and eight hundred to twelve hundred pounds of a high grade 4-8-4 fertilizer applied before the beets are sown should give good results on sandy loam soils. For richer, more alluvial soils both the nitrogen and potash might be reduced and for muck soils a fertilizer such as a 2-8-6 is suggested. Additional light applications of nitrate of soda have been found valuable, especially with the early crop.

Plants and Planting.—Early plants are started indoors, usually before March 1st. They are transplanted to flats one and one-half inches apart each way. When the land is fit to work and after the plants are hardened off they are transplanted in rows fifteen to eighteen inches apart and set four inches apart between plants. This method gives a beet ready for market a week to ten days earlier than those sown outside. Seed is sown outdoors, starting as soon as severe frosts are over. Successive plantings should be made in the garden. Seed drills are used commercially, sowing from four to six pounds of seed per acre in rows fifteen to eighteen inches apart. The seed is covered to a depth of three-quarters to one and one-quarter inches, depending on the type and condition of the soil.

Thinning.—Thinning should always be practised with seed-sown beets. It may be left until the largest are ready for use, then those left should be from three to four inches apart.

Cultivation.—Beets respond to cultivation and weeding. Shallow cultivation should be practised.

Harvesting.—For early bunching, the beets are ready to harvest when they have attained a size of one and a half to two inches in diameter. Bunches are made of from three to five, the beets being washed and all dead leaves removed. For winter use pull before severe frosts set in; twist the tops off instead of cutting. Pile the beets in small piles in the field and cover over for a few days to allow them to sweat and dry before the crop is stored.

BROCCOLI

Broccoli is a crop somewhat similar to cauliflower, little grown in this country. It requires a long season in which to mature and is not a sure crop. Cultural practices are about the same as for cauliflowers.

BRUSSELS SPROUTS

Brussels sprouts grow on a stem of eighteen inches to two feet in height along which at intervals are produced leaves. In the axils of the leaves small heads, or buds, develop. These are used similarly to cabbage for the table.

Culture.—The same general cultural methods apply to Brussels sprouts as to cauliflower. The plant will stand being left outside until severe frosts are liable. Seed is started early in the spring in a seed bed and the plants are later transplanted to the garden, two to three feet apart in the rows of three feet width. As sprouts develop, cut off the leaves one inch from the main stem.

Harvesting.—The sprouts are usually from one to one and one-half inches in diameter when ready for use, and this is from three to three and one-half months after the plants have been set out. When freezing weather sets in the plants are pulled or cut near the ground and stripped of their leaves. Afterwards they are stood upright in a cool cellar or shed, packed closely together and lightly covered with some material such as hay. They will stand some freezing, but not alternate thawing and freezing. The sprouts may be picked as required, stripped of the outer yellowed leaves and marketed in quart berry boxes. For home use the sprouts, if stored in a cool cellar, will keep well on into the winter.

CABBAGE

Cabbage is an important crop widely grown throughout the Province for early markets and use throughout the summer, for winter storing and for kraut and pickle manufacturing purposes. Its use is becoming greater as its value as a health food is better known. Cabbage is an excellent source of both Vitamins B and C, and kraut manufacturing does not spoil it.

Soil.—A wide variety of soil types is used in growing cabbage. For the very early crops light soils are used, while for the late crops clay loams or silts are preferable. Mucks are also used to some extent. Soil preparation should be such as to provide an early plant bed for the early crop, and for the late crop moisture conservation should be the aim.

Manures and Fertilizers.—Since cabbage is a gross feeder, especially of nitrogen and potassium, there should be an abundance of plant food readily available in good cabbage soil. If manure is used in quantities the addition of a phosphorus fertilizer will be warranted, as well, perhaps, as a small amount of readily available nitrogen. Manure in moderate quantities supplemented by the use of commercial fertilizers is the most desirable way of maintaining fertility in cabbage soils. Good results are obtained also in the use of cover crops and commercial fertilizers. Green crops of some sort are necessary to maintain the humus supply where manure is not used. A 5-10-5 on sandy loam soils where no manure is used is sometimes applied up to one ton per acre. For late crops on heavy soils, where a good rotation is used, including manure, 500 to 700 pounds of acid phosphate is recommended. If no manure is used some potash and nitrogen should be used. Light applications of nitrate of soda are often made during the growing season.

Growing Plants.—For an early crop seed is sown in flats in the greenhouse about March 1st. The seed is sown in drills and covered about one-quarter of an inch deep with sand. The seedlings are transplanted, while the first leaves are still small, into flats, about two inches apart each way, or into two and one-half or three-inch clay pots. The plants should be grown to produce

strong, sturdy, well-hardened plants by transplanting time. For the late crop, about five weeks before plants are wanted, the seed is usually sown in a specially prepared seed bed, not too rich. If the cabbage maggot is troublesome this bed may be screened off or the plants treated with corrosive sublimate several times.

Planting.—Well-hardened plants can stand a temperature of ten to fifteen degrees of frost, if not for too long. So that where early land is available the crop can be set out very early in the spring. Early plants are set about eighteen inches apart in rows thirty or more inches apart. The plants are carefully set by hand, removing as much of the dirt with the roots as possible from the box or pot. The late crop may be set out in June or July, about four months being allowed for it to mature. The plants are either planted by hand or by a mechanical transplanter. A little water supplied at planting with this crop is a great assistance in getting a good stand. Plants are set from two to two and one-half feet apart in good garden soils. Only the strong, stocky plants should be used at any time.

Cultivation.—Very shallow cultivation is the rule with cabbage after they have become fairly well grown. The roots are shallow and spread out and travel across the rows quickly. Cease cultivation when injury to the plants is apparent.

Harvesting.—Very early cabbage is harvested as soon as a marketable head is produced. Later on the heads are allowed to become full grown and hard. A knife is used for cutting the heads. Late cabbage in commercial quantities are allowed to become full size and hard and are then cut with a knife. Care is taken in handling them so as not to burst the heads. For home use the whole plant may be pulled and stored as such.

Storing.—Danish Ballhead is a good variety for winter storage, on account of its compact, hard heads. The cabbage to be stored should be sound and free from disease and injury. A good, uniformly cool place around 33 degrees F., where a fair degree of humidity may be maintained, is desired. When cabbage is kept inside it is best piled on slatted racks not more than two heads deep. Outside, the crop is stored in various forms of pits and trenches. Sometimes the heads are cut and stored in A-shaped pits as used for roots, or the plants, roots and all, may be pulled and stored roots down in the shallow trenches. Around the bed a frame is built and banked up with earth, while over the top straw or other material is piled. Ventilation should be provided in all pits, trenches and root cellars or storehouses.

CARROTS

Carrots are grown extensively by all vegetable growers and are one of the most popular, for use, of the root vegetables. They are considered very valuable from a dietetic standpoint and are advocated by doctors and others. Since they can be grown readily almost anywhere and kept in storage easily, they are available throughout the whole season at relatively low prices.

Soil.—Any good, loose, loamy garden soil will grow a good crop of carrots For early crops a sandy loam is preferred, but for the late crops and where higher yield is desired the loams and muck soils are better suited. A well-prepared seed bed is important for carrots with the soil well pulverized and smooth.

Manures and Fertilizers.—It is not well to apply fresh manure directly preceding a carrot crop, as it is believed to produce rough and knotted carrots. Carrot soils require much the same fertilization as for beets. On muck soils applications of potash and phosphorus fertilizers are recommended.

Planting.—Carrots are hardy and may be planted early in the spring. Successive plantings for steady use may be made on into July. The late crop, for storage, may be sown during June. Seed is sown either by hand or with seed drills, in rows twelve to eighteen inches apart. Since the carrot seed is small it should be lightly but firmly covered. It is well to sow a little lettuce seed with it to mark the row until the carrot seed comes up. The young plants are thinned to from two to four inches apart, the former for early bunching sorts and the latter distance for the main crop. Less space is given on muck soils, so as not to permit of the carrots growing too large.

Cultivation.—Keeping down weed growth is the important factor with the carrot crop, especially so at the time when the carrots are small. The wheel hoe is a very efficient tool for this purpose. Loose earth should be kept over the tops of the roots to prevent sunburning and discolouration.

Harvesting.—Bunching carrots are sometimes thinned from the main crop, being pulled when the upper ends have reached a diameter of three-quarters inch or more. Bunches of eight or twelve are made and the whole top or a part of it is left on. The carrots in the bunch should be clean and of uniform size. For a late crop, if the roots are long and to be removed all at once, a furrow may be run down alongside. The carrots are usually pulled by hand and topped with a knife, leaving about half an inch of the top. The carrots are piled, covered with the tops and left in the field a few days before bringing into storage.

CAULIFLOWER

Cauliflower is a member of the cabbage family, but is a less hardy crop than cabbage. It is much more particular in its demands in regard to the climate and seasonal conditions, and in general care. It thrives best under relatively cool, moist conditions and will not stand extreme heat. In Ontario the crop is grown mostly as an early crop or as a fall crop. Considerable areas are grown for pickle factories and a large annual production is needed to supply the retail trade since cauliflower is one of the most popular of vegetables in its season.

Soil.—Cauliflower may be grown on most types of soil, providing weather and moisture conditions are suitable. However, a deep, rich soil is to be preferred, one that contains a good supply of humus and is moisture retentive. For the early crop a warm soil well supplied with humus is desirable, while for the late crop clay loams and muck soils give good crops.

Manures and Fertilizers.—On light soils manures or green manure crops are necessary to keep up the humus content. Fresh manure should be applied the fall preceding the crop. Much the same may be said in general about the use of manures and fertilizers as for cabbage. Nitrate of soda may be applied in light applications each ten days or so up until the plants commence to head.

Seed.—Good seed is very important with this crop. A large part of our seed is imported from Denmark, and some excellent strains are to be had from this source. Good seed, even if high priced, is a profitable investment.

Growing Plants.—Except for the fact that young cauliflower seedlings are not so strong and hardy as cabbage and are more liable to "damp off," the growing of them is much the same. It is advisable to use sterilized soil in the seed and plant boxes and mix with it about one-third portion of sand. The seed for the early crop is not sown quite so early as cabbage, the dates being

from March 1st to 15th. Cauliflower plants should be strong and sturdy and well hardened before setting into the garden. For the late crop the seed is sown as for cabbage outdoors.

Planting.—The early crop is set out after the weather has become fairly settled. Long periods of cold weather, which check the plant, cause "buttoning" of the heads. The early plants are set eighteen inches apart in rows thirty inches or more in width. The late crop is usually given about twenty-four inches in the row in thirty-six inch rows, and is set by hand or by a transplanting machine. As much soil as possible should be retained around the roots. The plant is set fairly well down, but not so deep as to cover the leaves.

Cultivation.—This crop responds to cultivation, but as the plants develop cultivation should become more shallow.

Tying.—In order to produce pure white heads of cauliflower the outer leaves are usually brought up over the top of the young heads and tied. The material used may be raffia, twine, or rubber bands. Different coloured twine used on different days helps to distinguish the longer tied heads when harvesting is being done. The length of time required to bleach a head depends upon the weather. Two or three days may suffice in hot weather when the plants are growing rapidly, while in cold weather a week or two may be needed. The heads should be examined frequently to learn their condition of maturity.

Harvesting.—This operation commences when the heads have reached a proper size, and before "ricing" or discolouration starts. The head is cut from the root and trimmed to a fringe of leaves which are cut off about one to one and a half inches above the flower. Careful trimming aids in the appearance and marketability.

Marketing.—Cauliflower for market, especially if shipped, should be graded into at least two grades and better three. Crates are used in which from eight to twelve heads can be packed solidly and in such a way that the tops will not become rubbed and discoloured. A damaged head soon develops rot.

Storage.—Cauliflower is not an easy crop to store. Good sound heads with the leaves left on may be kept under proper cold storage conditions for several weeks. Many market gardeners store quantities which are pulled late in the season and not fully matured. The plants are removed to a cool cellar or frame, where they are stood close together and the roots covered with moist sand or loam. When outdoor frames are used, too much covering early in the season with improper ventilation will cause heating and rotting of the heads.

CELERIAC

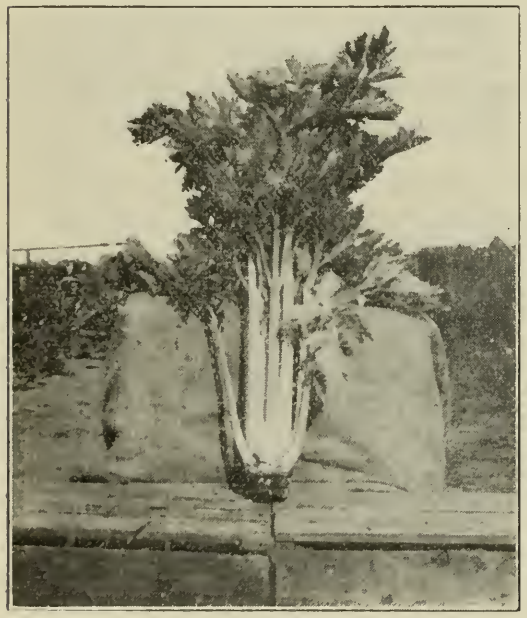
Celeriac, popularly known as turnip-rooted celery, is grown for its thick root, which is used both as a salad and a cooked vegetable. It has the flavour of celery, but is not a widely used vegetable in Ontario. The leaves are much similar to celery, and the crop is handled in the same way as celery, except that the leaves are not bleached. The roots are pulled and trimmed before being marketed.

CELERY

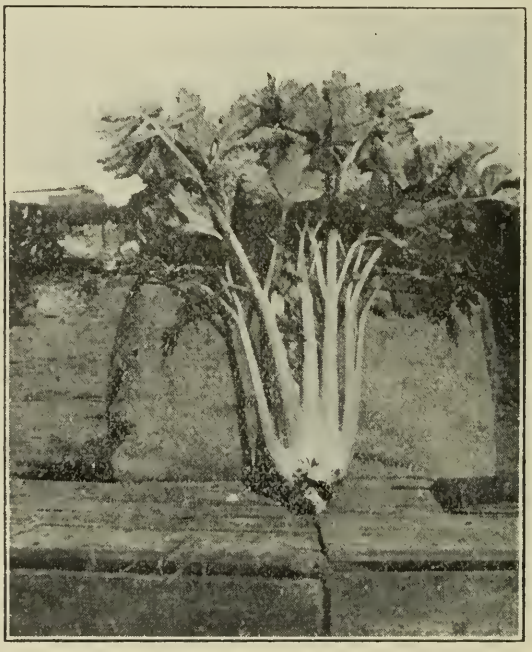
With the exception of lettuce, celery is probably the most popular salad crop grown in Ontario. It is used to some extent for other culinary purposes as well. Market gardeners everywhere count on celery as one of their important

crops. It is produced in large quantities in certain sections of the province, notably the Thedford district in Lambton county, as a special truck crop. Thousands of home gardeners grow enough celery each year for their own use.

Soil.—Celery can be grown on any rich, well-drained soil if of not too compact a nature. For the early crop a sandy or sandy loam soil, rich in humus, is preferred to any other of the upland soils. If irrigation is available such a soil is ideal for the early crop. The best natural soil for celery is a good type of well-drained muck, and it is on this type that the bulk of the crop is produced. Celery to be of good quality must have continuous growth and not be checked. Celery, growing under such conditions, is also inclined to be more disease-resistant. Since muck soils offer such conditions they are usually most desirable. Soil preparation should be very thorough for this crop; deep plowing and pulverizing of the soil are necessary. Before the planting and after the preliminary preparations the soil is usually dragged and rolled to make an even, firm planting surface. This is especially necessary with muck soils.



A typical plant of the new French strain of Paris Golden celery.



A typical plant of Wonderful or Golden Plume—a new type of Paris Golden celery.

Manures and Fertilizers.—The root system of the celery plant makes it a rather poor forager, but the crop is a heavy feeder and hence must have an abundance of available plant food to draw on. On mineral and upland soils, manure is usually used in large quantities up to forty tons to the acre. When this is the case a phosphorus carrying fertilizer should be used, such as acid phosphate at from 600 to 800 pounds per acre. Light applications of nitrate of soda can also usually be made to advantage while the crop is growing. Where green crops are used to supply the humus, up to a ton of 4-8-4 or 5-10-5 fertilizer is used by some growers.

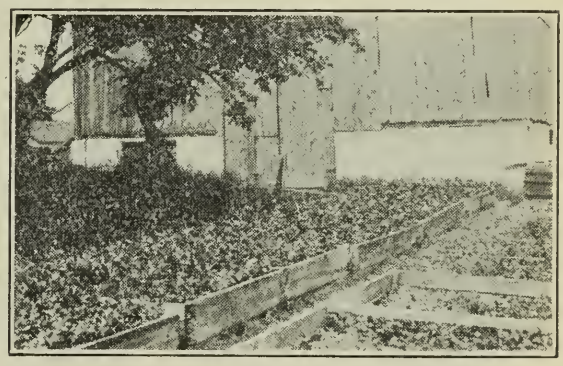
Muck soil, as a rule, is fertilized largely with commercial fertilizers, though where manure is available it is used to good advantage on muck. With this type of soil, fertilizers bearing a relatively high phosphorus content and a high potash content are best. In addition, light applications of nitrate of soda, made at intervals as the crop needs it, should give results. Such a fertilizer as a 2 to

4-8-8 to 10 should be suitable for the above conditions. Amounts used run up to one ton per acre. Liming of muck land for celery is practised by some growers to bring about better conditions for the decomposition of the vegetable matter in the muck itself. Results are thought to be favourable, but are not always readily apparent.

Growing Plants.—For the early crop the seed is started indoors in flats or beds from February 15th to March 10th. Light, fibrous soil, well pulverized, is used. The seed is sown in drills two inches apart, lightly marked to a depth of one sixteenth inch, afterwards being covered by fine sand sprinkled over the top. Sterilized soil should be used for growing the plants in order to avoid loss from "damping off" of the young plants.

The seeds take up to two weeks or longer to germinate, frequently, and it is another three weeks before they are ready to transplant. At this time the strong, healthy plants are transplanted into other flats or beds at one and one-half inches apart. This insures a good, strongly developed root system on the young plant to be later set out in the garden. The soil for this transplanting should be a good fibrous loam. Germination may be hastened by placing a

A solid bed of celery—a method sometimes used with the early crop.



Early celery grown in hotbeds following an earlier crop

glass over the seed box. Watering of the seed boxes should be done carefully so as not to disturb the seed, a piece of burlap laid over the top and the water poured over it will be found effective. Watering, after the young plants are growing, is best done in the morning of bright days.

Seed for the main crop or late crop is sown in outside beds and usually planted in April or May. In the Thedford district, on black muck, seed beds are prepared in the open fields and a fine, well-prepared seed bed is necessary. The seed may be very lightly covered with soil or not covered at all as on muck, or the seed may be covered with burlap till it germinates. Sowing the seed in rows offers a better chance for weeding, cultivating and thinning. About half a pound of seed, per acre of plants to be set out, is needed when grown in this way.

Setting Plants.—Plants grown for either the early or late crop should be well watered before being removed from the seed box or bed, and as much soil should be left adhering to the roots as possible. When planting in a dry soil, some water is desirable either before or after the plants are set in the row. Holes are made for the plant either with a dibble or other instrument and the plant is set firmly in the ground with the roots spread out. The plant must not be set too deeply, so that the heart will be covered. Planting systems vary. That most commonly used is to set the plants from six to eight inches apart in rows

three to four feet or more in width. Another system is to set two rows of plants six inches apart each way with a distance of three to four feet apart between the next two rows. Intensive cultivation is sometimes practised and rows are made twelve to eighteen inches apart. Still another method is to set the plants eight by eight inches apart in solid beds from six to ten feet wide. Only the outside rows then need artificial bleaching. Straight rows are very desirable and the distances between rows should be equal. This aids greatly in the operations of cultivation, spraying and bleaching.

Cultivation.—Cultivation should start right after the plants are set out and be continued at regular and frequent intervals thereafter, maintaining a surface mulch at all times and keeping down the weeds. Shallow cultivation, especially near the plants, is necessary to prevent root injury. Also care must be taken not to throw earth into the heart. About bleaching time cultivation should have been stopped on account of possible injury to the rootlets.

Celery bleaching—showing use of the patent celery bleacher.

Bleaching.—As the crop matures, bleaching of the furthest advanced lots should be commenced. As each lot is marketed another lot should be made ready to market, insuring a continuous supply in as great quantities as the market demand warrants. Bleaching is done to give the celery a pleasing white appearance and to improve its flavour and crispness. Various methods are in use employing earth, boards or paper. For the early crop the boards and paper materials are almost exclusively used while for the late crop, especially in the large commercial growing sections, soil banking is used.

The use of twelve-inch boards is a popular method. Two boards, twelve to sixteen feet long, are stood up close along the side of the row and held by a stake driven at each end. The stakes should be about three feet by one inch by two and a half inches, and are then wide enough to hold up the ends of two boards. These boards will last for a good many years if handled carefully and stored under cover when not in use. Another way of holding up the boards is by means of bent wire hooks stretched across or by pieces of lath tacked from one to the other. A little soil thrown along the lower edge of the boards will

close any small openings. A material similar to prepared roofing paper, but without the tarry odour, is on the market as a bleacher. It comes in rolls twelve inches wide and 100 feet in length, and is held close to the plants by means of long, staple-like wire hooks. Very good satisfaction is obtained by this method and with careful use the material will last for several years. It is much lighter to handle than boards and more convenient.

Where earth is used, it is banked up to the plant gradually so as not to cover the heart. In large gardens this is done by means of a hiller and the soil can be pushed right up to the top of the plants as cold weather approaches. Brown or white paper is sometimes used in a small way for wrapping around individual plants. Small wooden boxes or tile are also occasionally used in home gardens.

Harvesting.—For immediate use the celery should be well bleached, but where it is to be stored complete bleaching is not desired. In small gardens the celery is usually loosened with a spade, but in harvesting late crops in a large way horse-drawn implements are used. The plants are cut off below the surface of the soil with a portion of the roots attached. The diseased, broken or loose stalks are usually pulled off in the field as well as all suckers and loose dirt.

Marketing.—For local markets the celery is trimmed, washed and tied in bunches of one dozen heads usually. Where it is to be shipped as trimmed it is packed in clean boxes holding about three dozen heads. A great deal of celery is shipped to consuming centres in the rough, and it is always stored this way. The roots are left on and no washing is done. The heads are trimmed only of useless stalks and are packed in open slatted boxes frequently lined with brown paper to prevent excessive drying out of the celery.

Grading of the heads should always be practised both in shipping trimmed and washed or untrimmed celery. Three grades at least should be made. Neat, clean, well-tied bunches, good in quality, of trimmed celery are much more attractive to the buyer than carelessly prepared lots.

Storage.—Celery can be readily stored by various methods, suited to the needs of the home gardener, the market gardener and the large truck grower. It should be free from disease and mechanical injury, not fully bleached, and kept at a low temperature but not allowed to freeze. For keeping but a short time in the fall, trenches are often dug in the open field and celery stood up in these and covered with boards. Later, straw and soil may be thrown over the boards. Ventilation should be provided at all times. This method is limited in its use and not a very satisfactory one.

Pits or unused frames are often used, the celery being stood close together in these and soil packed around the roots. Boards or sash may be used to cover over the top and as cold weather advances the sides may be banked and the top covered with litter and soil. Ventilation should not be neglected. Where cool cellars are available the celery may be taken from the field and stood close up together with moist soil packed around the roots. This is the method best suited for keeping a home supply.

Cold storage is being used more extensively each year for storing the late crop within the province. Celery may be kept up to three months or more in this way. Temperature and moisture relationship are more under control and can be regulated. 32° F. is recommended as the holding temperature under cold storage conditions.

CHINESE CABBAGE

In some sections Chinese cabbage is grown by market gardeners in a small way. It is a plant that is classed among the salad crops, producing a head resembling cos lettuce. It may also be cooked as a green.

A rich soil, abundance of moisture and a cool season give best results with this crop. For early use it should be started indoors about four to five weeks before being set out. For a fall crop seed is sown outdoors and the plants thinned to stand ten to fourteen inches apart. When stored with roots on it will keep well into the winter.

CHIVE

This is a hardy perennial crop very little known in Ontario. The leaves of the plant are used for seasoning and for flavouring soups, omelettes, etc. The plant resembles the onion somewhat and produces small bulbs. It is most easily propagated by division of the clumps in which it grows.

CITRON

Most market gardeners grow a small quantity of citrons and many home gardeners grow sufficient for their own use. The plant does well on most fertile soil and is grown by much the same methods as recommended for watermelon.

SWEET CORN

To get the best from sweet corn for table use it should be used within a few hours after it is pulled from the stalk, as it rapidly loses its flavour and quality. For this reason sweet corn is grown largely by market gardeners to supply local markets and by home gardeners for home use. Large quantities are grown for canning purposes at different points within the province.

Soils.—Early corn is alone profitable to the market gardener; hence, a well-drained sandy loam, well supplied with humus, is desired for this crop. For the canning factory crop a somewhat heavier, more moist soil will give higher yields.

Manures and Fertilizers.—Both manure and commercial fertilizers are used with the early crop on light land. Ten to twelve tons of manure per acre, supplemented with 400 to 600 pounds of acid phosphate, should give good results. In addition, a light application of nitrate of soda early in the plant's growth should stimulate it. On the heavier soils, if in good condition or if a green manuring crop has been turned under, 400 to 500 pounds of acid phosphate alone should prove satisfactory. Broadcasting the fertilizer along the rows is generally the most popular method of applying it.

Planting.—Corn cannot be planted until after danger of frosts is over, though in order to get it early some risks are taken in this regard. For the home garden a succession of plantings at two or three-week intervals should be made on till July 1st in the warmer parts of the province. Sometimes a few early plants are started indoors in berry boxes and later planted outside. When hills are used, six seeds are planted to a hill and later the plants are thinned to three or four. The hills are spaced from two to two and a half feet apart to three and a half by three and a half feet apart, depending on variety and method of culture. In drills, the plants are thinned to stand ten to fifteen inches apart in the row.

Cultivation.—Before the corn is up and even after the plants are two or three inches high, a weeder or light, spike-toothed harrow is often run over the field. This breaks the surface crust and destroys millions of tiny weeds. Subsequent cultivation should only be given in order to control the weeds and should be shallow.

Harvesting.—Sweet corn should not be allowed to become too mature if the best quality is to be enjoyed. It should be harvested in the milk stage and put into the hands of the consumer as quickly as possible. Care must be taken not to pile quantities of corn for any length of time in poorly ventilated quarters or it will heat and spoil.

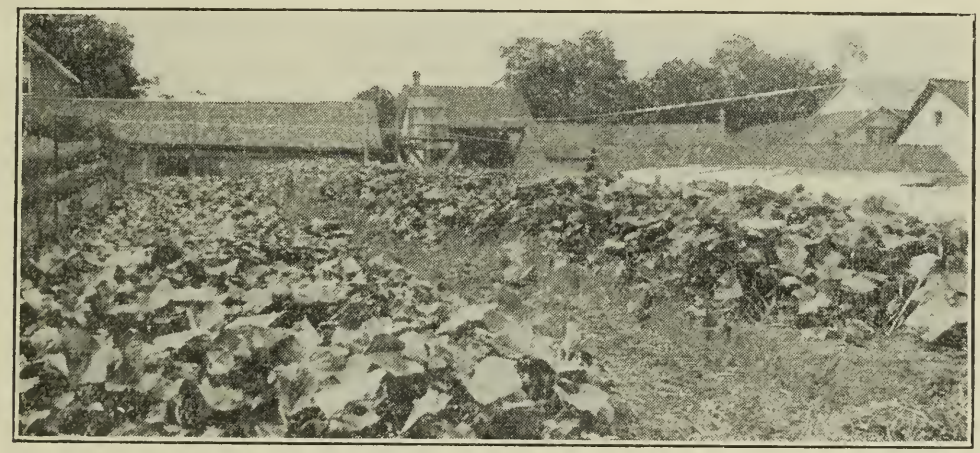
CORN SALAD

As the name denotes this plant is used for a salad largely, but is not a very popular vegetable crop in Ontario. It is a hardy, cool-season crop, easy to cultivate except during warm weather. The seed may be sown very early in the spring and the plants later trimmed to stand six inches apart in the row.

CUCUMBER

The cucumber is a widely grown vegetable crop within the Province of Ontario in home gardens, as a market garden crop and for use by pickle factories.

Soil.—Any rich garden soil is suitable for growing this crop, though where an early crop is desired a sandy soil is preferred. For high yields, however, heavier soil is desired, and the yields are likely to be higher and sustained for longer periods.



A crop of early cucumbers grown in hotbeds—the frames have been removed.

Manure and Fertilizer.—For cucumber soils there should be plenty of humus supplied either through the use of green manuring crops or of stable manure. If the former is used alone, 600 to 1,200 pounds of a high-grade fertilizer should be used, such as a 4-8-4. In using manure, where large quantities are available, the manure is applied broadcast, but if only limited quantities of well-rotted manure are to be had it will give best results if applied under the hill or row and covered over with soil. When manure is used, some phosphorus-bearing fertilizer can generally be profitably applied, such as acid phosphate at from 350 to 500 pounds per acre. A light application of nitrate of soda to give the plants a start is often very useful, especially in a backward season.

Early Plants.—For the early crop, plants are frequently started indoors five or six weeks before being needed for the garden. The seed is planted in quart berry boxes, pots or paper bands. Good loamy soil or pieces of sod are used and seven or eight seeds are usually sown in a container. Later, the two healthiest plants only are left. These plants are given every chance to develop

until set out into permanent beds. The permanent bed may either be a good rich part of the garden, in a warm, sheltered spot, or the plants may be set into frames which can be later removed as the plants develop and the weather becomes warm.

Planting Seed for Main Crop.—Both hills and drills are used in which to sow the seed. When hills are used, they are spaced from four to six feet apart each way, depending on the soil. Several seeds are planted in each hill and later thinned to the two healthiest plants.

The drill method is most commonly used in growing the crop for pickles. Seed is sown in rows six feet apart; a seed drill may be used, using from two to three pounds of seed per acre. After the plants are established they are thinned to stand twelve inches apart. This method is a labour saver and gives a good distribution of the plants.

Cultivation.—Weeds should be kept down by cultivation, hoeing and, later, hand-pulling. Shallow cultivation is continued as long as possible without causing injury to the plants.

Harvesting.—Size in relation to market demand governs the time of harvesting the crop. Slicing cucumbers are picked when they are from six to ten inches in length. Pickles are harvested from very small size to two and a half to five inches in length. For pickles, the vines will need to be picked over very frequently, at least every other day. Cucumbers should be carefully picked, leaving the stem on. Cucumbers should not be allowed to mature on the vine as this causes a heavy drain on the plant.

Marketing.—The fruit is usually graded and packed in eleven-quart baskets when being shipped either for slicing or pickles. Cucumbers for slicing should be rushed to market as they soon lose their quality if held. Refrigerator cars should be used for long-distance shipments.

DANDELION

As a green and for salads dandelion is grown to a limited extent by market gardeners. It is a cultivated strain of the wild species that is used.

Soil.—Light, loamy soils are preferred, but any good garden soil will produce a crop.

Planting.—The seed is planted in rows fourteen to eighteen inches apart and the plants thinned to stand eight to ten inches apart in the row.

Treatment.—Much the same treatment is given as for lettuce. Flowers should be removed as they form, and nitrate of soda in light applications will hasten and improve the crop.

Bleaching.—When used as a salad the leaves are best bleached either by tying together as with cauliflower or by the use of boards as with celery.

Harvesting.—The whole plant is pulled, the roots trimmed off and the leaves washed and prepared for market.

EGGPLANT

The eggplant is one of the most tender plants of our vegetable crops and is very sensitive to frost. It is necessary to start the plant indoors and grow it under shelter until all danger of frost is over. It can only be grown successfully in those parts of the province where long seasons are the rule and frosts do not occur early.

Soil and Fertilization.—Warm, well-drained rich soils are best suited for this crop. Plenty of manure, if available, is used, or liberal quantities of a high-grade commercial fertilizer. Some readily available nitrogen is useful immediately after transplanting.

Plants and Planting.—Seed is sown indoors from February 15th to March 1st. The plants are usually transplanted, at least once, starting as soon as the rough leaves appear, and are grown in four-inch pots until set out into the garden. Care must be taken of the plants while growing to guard against any check in their growth. After all danger from late frosts is over and warm weather has appeared the plants are set out into the garden in rows thirty to forty inches apart, allowing from twenty-four to thirty inches between plants.

Cultivation.—The cultivation is the same in general as that recommended for tomatoes. It should cease when the fruits reach a fair size.

Harvesting.—The fruit is edible over a considerable period, from the time it is one-third grown until fully ripe. The fruit should, however, be well coloured for market. The fruit is cut from the plants, leaving the calyx and a portion of the stem.

Marketing.—Eggplant stands shipment well. Baskets are sometimes used for shipping them in, but a crate of some sort is preferable. The fruits should be packed so that the stems do not damage other fruits.

ENDIVE

Though one of the oldest known vegetables this crop is not widely grown in Ontario. It is excellent and compares favourably with lettuce as a salad. It is grown for early summer or for use in the late fall and is most often seen in the latter season.

Culture.—In general, the methods of culture and requirements for endive are similar to those of lettuce. The crop will withstand light frosts and may be sown in the spring and will continue growing on into the fall.

Bleaching.—When used as a salad it is best bleached as this reduces the bitterness of the leaves and makes them more tender. Tying of the leaves in a bunch at the top is a common practice; other methods, including the use of boards, are used. Care must be taken to watch that decay does not develop at the crown during wet weather. In cool fall weather it may require two or three weeks or more to properly bleach the inner leaves.

With the late crop it is sometimes removed from the field and transplanted into moist sand in a cool cellar where it will bleach.

GARLIC

Garlic is used for flavouring soups and stews to some extent. In America it is popular amongst foreigners and is largely used by them.

Unlike the onion, garlic produces a group of small bulbs encased within a thin skin. These small bulbs or cloves are used to propagate the plant. The plant also produces small bulblets in the head of the seed-stalk.

Culture.—The crop requirements are practically the same as for an onion crop, the cloves being set three to four inches apart in rows fourteen to eighteen inches wide. When the tops are ripe the bulbs are pulled and, having been allowed to dry, are often braided together, bulbs on the outside, and hung up in a dry airy place to cure. They may be sold either in braids or as bulk bulbs.

HORSE-RADISH

Horse-radish is often found growing in farm gardens more or less as a weed. It is cultivated to some extent by market gardeners and in a few places is produced as a commercial crop.

Soil.—The crop does best on a deep, rich, well-drained but moist soil. Shallow or hard soils are not desirable.

Manure and Fertilizer.—If the soil is not already rich, an application of well-rotted manure should be made, and in addition some phosphate fertilizer will usually be found profitable to apply. From 500 to 700 pounds of acid phosphate should be suitable. If no manure is used a fairly heavy application of a high-grade fertilizer should be made on the lighter types of soil.

Planting.—The crop is grown from cuttings from old roots. These cuttings are usually made from side roots one-quarter to one-half inch in diameter and should be straight and preferably long. They are prepared in the fall and stored in bundles over winter, packed in sand in a cool and fairly moist atmosphere. In the spring they are set either in a deep furrow or in holes made by a dibble. The top end is always planted up and the cutting set at a slant and about three or four inches below the surface soil. Cuttings are set ten to twelve inches apart in rows three feet to three and a half feet wide.

Cultivation.—Cultivation should be thorough and continued throughout the growing season. Some growers trim off the side roots which develop early in the season. This is to give a large, straight root. If not carefully done, injury is liable to result to the root.

Harvesting.—Since the roots are hardy, they may be left in the soil over winter. However, they are usually plowed or dug out in the fall of the second year, the side roots are trimmed off, the leaves cut and the crop either sold or put into a cool storage where it will not dry out. In order to prevent the horse-radish from becoming a pest all pieces of root should be removed from the soil if another crop is not wanted in the same ground the following year.

KALE

Kale has never become a popular vegetable in Ontario, although it should be more widely grown in home gardens than it is. The plant belongs to the cabbage family, but does not form a head or produce edible flowers as do cabbage and cauliflower, respectively. The curled leaves are harvested and cooked. Since kale is a hardy plant and does not thrive in hot weather, it is best grown as a fall crop. It is often used for exhibition and ornamental purposes, and for such should be transplanted into a pail or tub, or set in the field, so as to allow plenty of room for development.

Culture.—Good garden soils are suited to this crop and, as for other vegetables, should be well prepared. The soil should be well supplied with plant food and kept in a good state of cultivation. The treatment after being planted is similar to that given for other leafy crops.

KOHL-RABI

Kohl-rabi is not as well known nor as popularly grown in Ontario as its value as a vegetable should warrant. If used before it becomes tough and stringy it is an excellent vegetable, but to be of good quality it must grow rapidly without any check.

Soil.—Any good, rich garden soil well prepared and fertilized is suitable.

Planting.—The seed is sown in rows from eighteen to thirty inches apart, depending on the method of cultivation to be used. Plants are thinned to stand from eight to ten inches apart. Plantings made at intervals of from ten days to two weeks will give a succession of good crops of this vegetable.

Harvesting.—Harvest before the swollen stem becomes tough and fibrous, usually this should be when the edible portion has reached a diameter of two to four inches.

Storage.—Some varieties may be stored fairly well in a darkened cellar.

LEEK

The leek is a very closely related vegetable to the onion. It is a biennial and is grown for its leaves which, when bleached, are tender and of milder flavour than the onion.

Soil.—Deep, rich, moist, fertile soil in good condition is best for this crop.

Planting.—Plants may be started indoors, or in a seedbed, and transplanted to the garden, or may be sown directly in rows sixteen to eighteen inches apart or more, and later thinned to four to five inches apart in the row. Some growers set the plants in trenches or holes six inches deep and allow these to gradually fill in. Others plant on the flat and bank up the soil to bleach the plants. Care must be used in banking or else rot may follow.

Storage.—Leeks may be stored outdoors in trenches, as recommended for celery, or in boxes in the cellar.

LETTUCE

Probably no other salad crop is grown or used to the same extent as is lettuce. It is very important as a truck grower's crop, as a market gardener's crop, and practically every home gardener grows some lettuce. With the production of large quantities of leaf lettuce grown in greenhouses during the winter months

Grand Rapids leaf lettuce, grown outdoors from seed.

Outdoor-grown New York head lettuce, from transplanted plants.

and, in addition, the quantities of head lettuce that are imported, a plentiful supply is to be had the year round. Lettuce does best under fairly cool seasonal conditions and is most successfully grown out-of-doors during the spring and fall. Good crops of leaf lettuce are produced in both hotbeds and cold frames in the spring of the year.

Soil.—Most types of soils will grow lettuce fairly well, but sandy loams, silt and clay loams and mucks are used to a large extent, the first mentioned for the early crop. Muck soil, on account of its high moisture content, is largely used for the summer crop. In preparing the soil, very thorough preparation is necessary to provide a deep bed with a smooth, level surface.

Manure and Fertilizers.—In order to grow a good crop on the lighter, earlier soils, it is necessary to keep up the humus content of the soil to a high standard. Barnyard manure or green manuring crops may be made to supply this need. Where manure is used, moderate applications of about twelve to fifteen tons per acre are made supplemented with some commercial fertilizer applied at about 1,000 pounds per acre. A good mixture is one containing five to six per cent. of nitrogen and ten to twelve per cent. of phosphate and, if desired, two to three per cent. potash. However, it is doubtful if potash is necessary. With green manures, 1,200 to 1,600 pounds per acre of a fertilizer mixture containing four to six per cent. nitrogen, eight to twelve per cent. phosphorus and four per cent. potash, should give good results. On muck soils a small amount of readily available nitrogen is desirable for use by the plant early in the season, eight to ten per cent. phosphorus is desirable and about four to six per cent. of potash. Nitrate of soda in light applications is often made to the growing crop under all soil conditions.

Growing Plants.—Hotbeds and greenhouses are both used for starting the plants designed for use as a first early garden crop. Seed is planted eight or nine weeks before time for setting out and is transplanted once into flats usually at about one and a half inches apart. Sometimes pots are used for head lettuce. Plants should be hardened off before being transplanted out-of-doors. Out-of-door seeding may be started quite early. The seed should be only very lightly covered with soil. Successive sowings at ten-day or two-week intervals will give a steady supply of fresh lettuce. For head lettuce the plants should be thinned or set to about eight to ten inches apart in the row in rows sixteen inches apart or more.

Cultivation.—Lettuce plants have a small root system, much of which grows near the surface. It is important, therefore, to keep down weeds and to maintain a surface mulch. Of necessity shallow cultivation must be practised and with frequency.

Harvesting.—Leaf lettuce is harvested at any time during its growth and as long as it retains its quality. Head lettuce is usually left until the heads are of full size and solid. A long, sharp knife is the best tool for use in the harvesting of the crop and usually the leaves next to the ground are left uncut.

Varieties.—Grand Rapids is the most popular of the crisp-leaf, non-heading varieties, while Nonpareil, Iceberg and New York are popular crisp-leaf heading sorts. Big Boston and May King are good examples of head lettuces of the butter-leaf type.

MUSKMELONS

As a truck crop, muskmelons hold an important place in the earlier truck-growing districts of the province. The Leamington and Burlington districts are especially noteworthy for this crop. Market gardeners, as a rule, grow some melons and many home gardeners do so as well.

Soil.—In the early districts a well-drained, fertile, sandy loam is considered the best type of soil. Melons may be grown on a wide range of soils, but for a profitable crop and in many cases, in order to have the crop ripen at all, an early soil is needed.

Manure and Fertilizers.—Where manure can be secured it may be used in fair quantities to good advantage with this crop. Owing to the nature of the land on which the crop is grown it is very necessary to keep up the humus supply with some form of manuring. Where a small quantity of manure is used it is best applied in the hill and in addition some phosphorus-bearing fertilizer in moderate quantities seems to give paying results. Where no manure is used, applications of 1,000 to 1,500 pounds per acre of a high-grade fertilizer such as a 5-10-5 might be made.

Growing Plants.—In Ontario it is practically necessary to start the seed indoors. The seed should be sown about four or five weeks before the outdoor transplanting time. Pots, strawberry boxes and inverted sods in frames or beds are used and several seeds sown in each. Later they are thinned to two or three; in the case of potted or box-grown plants, only one plant is left. The plant is kept growing and repotted if necessary, to produce a sturdy, well-grown plant just commencing to run at setting-out time.

Planting.—The melon is a very tender plant and liable to damage from late spring frosts. Some growers use small frames in which the melons are set and allowed to grow for the first few weeks. The frames are later removed. When planted in hills, the hills are spaced about six feet by six feet apart.

Cultivation.—Frequent, careful, thorough, shallow cultivation is the rule with the melon crop. It is carried out until vine injury is liable to result, then hand pulling of the larger weeds may be done. When a small number of vines is grown and highest quality in the melons is desired, the melons should be frequently turned. It may also be advisable to place some straw or a shingle under the melon to protect it from the ground.

Harvesting.—For local markets, the fruits should not be pulled until fully ripe. At this stage the stem will separate readily from the melon with but slight pressure being applied. When the melons are to be shipped any distance they should be pulled just before reaching this stage. Melons should be graded according to size, shape, colour, and condition of ripeness, and only good melons should be packed and shipped to market.

ONION

The onion crop ranks well to the fore in commercial importance amongst the truck crops grown in Ontario. Market gardeners usually grow a considerable quantity of onions of one or more types. The home garden would not be complete without this crop being represented. In the counties of Kent and Essex alone there is in the neighbourhood of 1,500 acres devoted to the intensive production of this crop.

Soil.—Onion crops are grown on most soil types from sandy loams to clays and muck soils. Clay soils, unless lightened by the addition of humus-making material, are generally not satisfactory. Sandy loams, if well manured, are good, and muck soils are the most desirable for the main crop since they are of organic origin, being rich in nitrogen, and have high water-holding capacity. Onion soils must have very thorough preparation. The seed bed should be well pulverized and smooth. Rollers and plank drags are commonly used on the muck soils to firm and smooth the soil.

Manures and Fertilizers.—On upland soils manure of some sort is necessary to supply humus where the onion crop is to be grown. On muck soils manure is not so necessary, though beneficial results are to be noted following

its use. It is best applied to the preceding crop. Where manure is used on upland soils the addition of 500 to 800 pounds of acid phosphate is recommended and, in addition, an application of 125 to 150 pounds of nitrate of soda is often desirable after the plants have become nicely rooted. For a complete fertilizer where no manure is used 1,000 to 1,500 pounds per acre of a 4-8-4 should prove useful.

A good stand of onions from seed.

Prizetaker onions as a transplanted crop.

Muck soils respond to the use of all three elements, though potash and phosphorus seem to be mainly required. Nitrogen in the form of nitrate of soda would appear to be useful if applied in one or two light applications early in the growth of the crop. Recommendations for the use of phosphorus range from 600 to 1,000 pounds per acre of acid phosphate, and of potash from 200 to 400 pounds per acre of muriate of potash, or somewhat less of carbonate of potash.

Grown from Seed

1. *Main crop.*—The bulk of the main crop of table stock onions is grown from seed. Onion seed of poor germination is often obtained, and a test should be made before planting. For this crop, where the rows are made about sixteen inches apart, four to six pounds of seed per acre are usually sown. The seed should be covered to a depth of about half an inch in light soils.

Curing onion sets in the field—
Exeter district.

Egyptian perennial onions.

2. *Pickling crop.*—This crop is grown from seed in the same manner as the above, but a greater quantity of seed is used. About thirty pounds of seed per acre are sown as a usual thing.

3. *Dutch Set production.*—In the districts surrounding Hensall and Exeter, in Huron County, quite an industry has developed in the growing of onion sets. Seed is sown in light but fertile land, early in the spring, at from forty to eighty pounds per acre. The seed is sown in rows three to four inches wide and about twelve inches apart. The sets mature during the warm weather of late summer and early fall and are dried and cured in the field and storage houses. Various grades are made before the crop is distributed.

Grown from Bulbs

1. *Main crop.*—Dutch sets are used to some extent in producing an early crop of mature bulbs. Sets one-half inch to three-quarter inch in diameter are in most demand for this purpose.

2. *Green Bunching Onions:*

Sets are used to some extent for this purpose, being planted early in the spring in a warm soil.

Egyptian or tree onions produce sets in the top of the flower cluster and these are grown to establish a permanent bed of this type of onion.

White perennial onions are grown for bunching purposes, the seed being sown from mid-August to early September, in rows fifteen inches apart. They should be thinned to two inches apart and will produce good green onions in the following spring.

Green onions are often forced in greenhouses or hotbeds by allowing fair-sized onion bulbs to sprout and grow in a warm temperature.

3. *Transplanted Onions:* Still another method of growing onions is practised, chiefly by market gardeners who wish to produce large mild onions of the Spanish onion type.

Seed of Prizetaker, Denia, or Riverside Sweet Spanish, is sown in flats, in rows about two and a half inches apart, about the last week in February. It is best to transplant the seedlings to about one inch apart each way, but it is not necessary in order to grow plants. As the plants grow the tops are kept clipped off to three and a half inches in height, thus inducing a stalky, well-rooted plant. The plants are set out after severe frosts are over. The plants are set five to six inches apart in rows sixteen to eighteen inches apart.

Cultivation and Weeding.—Weeds must be kept under control and surface cultivation is maintained just as long as possible without injury being done to the tops. Hand-propelled weeders and hand hoes are usually used, along with a certain amount of hand weeding which is necessary.

Harvesting.—When the crop is mature the fact is indicated by the drying up and falling over of the tops. The roots soon die and then the onion should be pulled and allowed to cure and dry, which will take a matter of a few days during bright weather. The onions may be topped in the field or removed to a shed and a topping machine. The crop is gathered in slatted boxes, is graded and sacked in loose, open-mesh sacks if to be shipped. Small quantities are best stored in open slat boxes or on shelves in which a good air circulation is present. Where it is desired to hasten maturity the tops are sometimes bent down when nearly ripe.

Storing.—Slatted crates are desirable, but any method which will allow free air circulation is good. The temperature of the storage room should be kept between 33° F. and 40° F. and a dry atmosphere maintained.

PARSLEY

Parsley is classed among our garden herbs and is one of the best known and most popularly grown of these. The leaves of the plant are extensively used for flavouring and for garnishing. The plant itself, in winter, is quite attractive from an ornamental standpoint.

Culture.—Owing to the fact that parsley seed is slow to germinate it is often found advisable to start the seed indoors or in a special seed bed, later transplanting the plants to the outdoor garden. This, however, is not necessary in central Ontario. The plant is hardy and may be set quite early in the spring. For winter use plants are lifted late in the fall and potted or benched in a greenhouse kept fairly cool, about at lettuce temperature is satisfactory. These plants will give a continuous crop throughout the winter if only a few leaves are picked from each plant at a time. Light applications of a readily available nitrogen fertilizer will be found useful in hastening the growth of parsley.

PARSNIP

Parsnips are not as popular as a vegetable as are many of the other root crops. They occupy the ground for the whole season and at the price which they bring are not considered a very profitable crop for gardeners to grow who are operating high-priced land. Like other more common root vegetables the parsnip is a biennial and produces seed the second year of its growth.

Soils.—Any good, deep, rich, mellow garden soil is suitable for growing this crop. Heavy soils are not desirable, as it is difficult to secure a good stand of plants in such soils as well as smooth roots.

Growing the Crop.—Parsnip seed should be planted early in the season. It is sown directly in the garden rows and a liberal quantity of seed is used since parsnip seed soon loses its germinability. Drills sixteen to eighteen inches apart and twenty-eight to thirty inches apart for hand and horse cultivation, respectively, are used. The seed is covered fairly lightly, and it is a good thing to sow some radish or other quick germinating seed with it in order to mark the rows. Once the plants become well established they are thinned to stand two and a half to five inches apart in the row.

Cultivation.—Cultivation should start as soon as the rows become marked as the young parsnip plants are unable by themselves to compete with the weeds. Crust on the soil surface should also be prevented.

Harvesting.—Harvesting usually is not commenced until late fall, and often a part of the crop is left in the ground until early spring of the following year. The roots are lifted by digging out or by running along close to the roots with a plow and turning the furrow away from the plants.

Inquiry is frequently made as to the poisonous effects of parsnips when left in the ground all winter and harvested in the spring. So far as we can learn no definite information has been learned to prove that they are poisonous under these conditions. However, we never advise their use after growth has commenced in the spring and would rather advise fall harvesting and storing of the crop.

PEAS

Green peas, though a much appreciated table vegetable, are not grown as largely by market gardeners as some other crops, chiefly on account of the expense of harvesting the crop. Where there is room in the home garden the crop is a

popular one. Large acreages are devoted to the growing of peas for canning purposes in various parts of the province, as this crop ranks about third in value among the vegetable crops canned.

Soil.—For the early crop a sandy loam soil is desirable, but where larger yields are of chief importance a clay or silt loam is preferred. Peas demand a well-drained soil and will not thrive on a water-soaked soil though for a good crop they require plenty of moisture. Thorough preparation of the seed bed is essential with the top three or four inches being left in a finely pulverized condition. Where the crop is grown on a large scale a level surface is desirable to aid in harvesting operations.

Manure and Fertilizers.—As a rule, where peas are grown on a more or less extensive scale, manure will appear in the rotation. It is not advisable to apply fresh manure directly before a crop of peas is grown. It is better applied and worked in in the fall or with some preceding crop. Where any of the legumes are turned under as green manure, barnyard manure is not considered necessary.

It is usually profitable to apply some commercial fertilizer to the land for peas under any circumstances. Where the soil is already rich and the peas are grown in a good system of crop rotation, a phosphorus fertilizer would probably be most useful. As soils become poorer there is more need for the use of a little nitrogen, especially in a readily available form and perhaps on light soils a little potash might prove useful as well. A complete fertilizer, if used, might be built up, such as a 2-10-4.

Planting.—The hardy, early varieties such as Alaska, a smooth pea, are planted just as early in the spring as possible. The wrinkled types are not quite so hardy, but will withstand slight frosts. Seed may be sown in rows thirty inches apart and the seeds planted from one to one and a half inches apart in the row. Seed is usually sown at a depth of from one and one-half to three inches, the greater depth as the season advances. Successive plantings at ten to fourteen-day intervals should be made up until about May 1st, or varieties of different periods of maturity may be planted.

When the crop is planted with a grain drill, the seed is sown at the rate of from three to five bushels per acre. Alternate openings of the drill are stopped, this allows for early cultivation. In gardens the hand seed-drill is often employed.

Cultivation.—In the garden cultivation is usually continued till vine growth interferes. In field culture it is only possible to cultivate the crop for a short time in the early season.

Training.—In the home garden the tall growing varieties of peas are often supported by brush, wire netting or twine supports. Commercially supports are not used to any extent.

Harvesting.—The home gardener may make several pickings from his vines, but the market gardener rarely goes over his patch more than twice. For the factory the vines are cut with a mowing machine and hauled to the factory when the majority of the crop is considered to be in prime condition. Pods should be well filled with fresh and not over-ripe peas when harvested.

PEPPERS

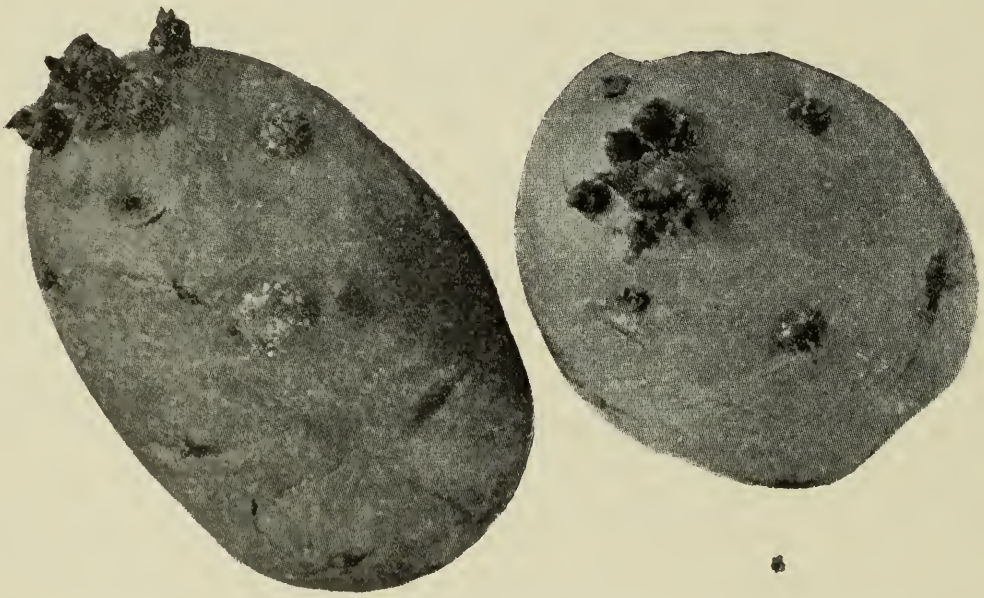
Peppers are a popular and widely-grown truck crop. Market gardeners usually grow some also and generally grow more varieties than the truck grower to meet their trade demands.

Culture.—The plants are very tender and require a long season of growth. They should be started indoors about March 1st, usually, and are handled very much the same as tomatoes while being grown. In the field they are set out after danger from frosts is past. A well-drained sandy loam soil which will encourage continuous growth is desired. Plants are set about eighteen inches apart in rows from two and a half to three feet apart, as a general rule.

Harvesting.—Large sweet peppers are usually picked while still green, in the early part of the season, though later there is a demand for some red ones. The stem is broken off, a small portion being left on the pepper.

POTATOES

The potato crop is one of the four principal food crops of the world. It represents the greatest area of land devoted to the production of any one vegetable crop in practically all countries where it is grown. In Ontario the potato crop is one of great importance. There are certain well-defined areas where it is grown almost exclusively as either an early crop or as a late crop. Other districts of a more intermediate nature may grow a proportion of both crops.



Potato seed sprouted in the light and showing the proper stage for planting.

The real early districts are found along through parts of Peel, Wentworth, Lincoln, Norfolk, Elgin, Kent, Essex, and Lambton counties. The late crops and seed crop are grown pretty generally throughout the rest of the province, extending up as far as Cochrane and west to Kenora and Rainy River Districts. Middlesex, Dufferin, York, Ontario and Simcoe counties are large producers of the late crop.

Soil.—The market gardener and truck grower aim to grow an early crop and hence desire a well-drained, early soil of a sandy or sandy loam nature. However, such a soil must be well supplied with humus and be moisture retentive, as well as rich in plant food. For the late or main crop any good loam, well-drained, friable and rich in plant food should give a good crop. Thorough soil preparation is essential in all cases.

Manure and Fertilizers.—Crop rotations play an important part in fitting soil for potatoes and it is generally considered that potatoes, following a clover sod, preferably manured and plowed under the previous fall for the early

crop, is a good practice. By whatever means adopted the soil should be kept rich and open. Manure if used is best applied in the fall or with a previous crop as fresh manure is liable to make favourable conditions for the development of scab.

Commercial fertilizers play an important part in combination with such treatment as is suggested above. Under most soil conditions phosphorus is the chief additional need, but with the lighter earlier types of soil some potash gives a profitable return. Where clover and manure are used it is generally not considered that nitrogen is needed, except in some particular cases with the early crop. Here, light applications of nitrate of soda are sometimes found to give good results. On lighter soils, where manure and clover are used, an 0-(10 to 12)-4 applied at the rate of from 800 to 1,200 pounds per acre should give good results. With heavier soils, under the same treatment, the potash could be cut down somewhat. For a complete fertilizer, such a one as a 2 to 4-(10 to 12)-4 to 6 applied up to one ton per acre where no manure is used, is to be recommended.

Planting.—Sets containing two eyes and of at least two ounces in weight should be used. These are planted from nine to fifteen inches apart in rows from thirty to thirty-six inches wide. The further spacing being for the late crops, four to five inches is the usual depth for planting potato sets.

Sprouting Potatoes for Seed.—Many market gardeners and home gardeners sprout their seed potatoes before cutting into sets. This is done by exposing the potatoes some two weeks before planting time to the light. The potatoes are spread out along the floor or in flats or shallow boxes in a greenhouse or a well-lighted barn or room where they will not freeze. Young sprouts soon develop and these grow thick and become firmly attached to the tuber. In length they should not be more than about half an inch. With careful handling and hand planting these sprouts may be planted intact with the sets and should produce a crop ten days to two weeks earlier than the unsprouted sets. Where cut seed is to be held over, the best material to treat it with is wood ashes or gypsum. It is best, however, to plant potato seed as soon after cutting as possible. Treating with lime may tend to encourage scab development.

Cultivation.—Plenty of cultivation early in the season meets with marked response from the potato crop. Weed control is the important factor in the cultivation. Deep cultivation should take place frequently early in the season, but later, as the roots develop, shallower cultivation should be the rule. Some growers make it a rule to cultivate after every rain early in the season, and many growers start to harrow over the potato field as soon as it is planted, continuing this operation frequently, until the potatoes are up two inches to three inches high. Hilling, especially with the early crop, should only be done in order to smother weeds and prevent sunburned potatoes. The same applies generally to the late crop.

Harvesting.—The early crop is often harvested before it is fully mature, in fact the size of the potatoes and the market demand influence the date of harvest. With the late crop, however, where the season allows for maturity, it is not dug until fully ripened. For small lots, the digging fork is commonly used while for greater areas the plow sometimes is used, but more frequently the potato digger. Care must be exercised with any method so as not to damage the tubers and spoil them for storage purposes.

Storing.—Potatoes may be successfully stored in cellars or pits. When cellars are used there should be provided plenty of air circulation around the

potatoes. The temperature range should be between 33° F. and 40° F. and the atmosphere should be just medium moist. Bins should have a false, slatted bottom and, if possible, large air shafts through the pile of potatoes. Pits should be constructed in a well-drained location and made twelve to sixteen inches deep and four to five feet wide. Plenty of ventilation should be provided and yet sufficient covering as the weather grows colder to prevent freezing of the potatoes.

PUMPKIN

A considerable demand exists each season for pumpkins for use in making pies, and most market gardeners grow a quantity. The small Pie Pumpkin gives the best in quality and grows to a popular size for use by the average housewife.

Culture.—The plants of the pumpkin are more hardy and require a somewhat shorter season in which to mature than do those of cucumbers and melons. Any good, well-drained soil is suitable and usually the seed is sown in whatever land is available, or along with a corn crop. When planted in hills the distance apart varies from eight by eight feet to ten by twelve feet. In drills the seed is sown in the row and the plants thinned to three to four feet apart.

Storing.—After becoming well-ripened, pumpkins may be carefully cut off at the stem and stored in a comparatively warm, dry room with plenty of ventilation. They should be carefully handled and not bruised.

RADISH

On account of its adaptability, the ease with which it may be grown and the fact that the radish, in the spring, is about the first vegetable to be fit for use, it is a very popular crop with the home gardener. Market gardeners and truck growers raise large quantities of this crop both out-of-doors and under glass.

Soil.—The crop may be grown on all types of soil, but for an early crop a good, friable, warm loam is preferable. For a summer crop a cooler soil, containing more moisture, is better.

Manures and Fertilizers.—When manure is used it should only be used when well rotted. Avoid fresh manure. What commercial fertilizers are supplied should be in a fairly available form. When manure is plentifully supplied the addition of an available phosphorus-bearing fertilizer should prove the chief need. A small quantity of some ready form of nitrogen might aid the crop. Where a complete fertilizer is needed a 4-8-4 or 5-10-5 should be suitable.

Culture.—Seed is sown out-of-doors as early as possible in the spring in well prepared land. Drills fifteen to sixteen inches apart are usually used where the crop is not grown as a companion or intercrop crop. Successive plantings made every ten days will ensure a steady supply.

Winter radish seed is sown in drills about the first week in July. This crop is harvested in the fall and stored similarly to the turnip crop after having the tops cut off.

The early radishes are pulled when large enough for use and bunched with five to ten radishes in a bunch. They are then usually washed and, if destined for distant markets, are packed in baskets, boxes or crates.

RHUBARB

Rhubarb is a widely grown and a popular crop with all classes of gardeners. In the home garden it should occupy a position at one side of the garden on

account of its permanent nature. During the winter, large quantities of forced rhubarb come onto the market and, in the spring, rhubarb occupies a very important place for use in sauce, in making pies and for preserving purposes.

Soil.—A deep, rich sandy loam is generally considered best for rhubarb, though the crop will grow successfully on almost all soil types and is frequently grown on such locations as side hills where it would be difficult to work other crops.

Manure and Fertilizers.—Where best results are desired the soil, before a rhubarb crop is set out, should be well enriched and put into first-class condition. Yearly applications of manure are made thereafter or, if no manure is available, 1,200 to 1,600 pounds per acre of a good, high-grade, complete fertilizer such as a 5-10-5 should give results. There should be plenty of plant food available to the plant after the cutting season to enable it to store up a reserve food supply in its roots for next season's crop.

Propagation.—Rhubarb may be grown from seed, but the more common way to propagate the plant is by means of root divisions, which ensure a continuance of the same variety. Plants grown from seed produce wide variations in type and other qualities. Where plants are grown from seed it may be started indoors and transplanted outdoors in rows three feet apart and sixteen inches apart in the row. The following spring the plants are lifted and set down about six inches deep in the permanent bed. Root divisions are simply made by cutting the old roots or crowns into pieces, by means of a spade, leaving one good eye to each crown.

Planting.—Either in the spring or fall is a satisfactory time for making new plantings, though in Ontario the spring is generally found to be most suitable. The pieces of root are planted four to five inches deep in rows four to six feet apart and from two to three feet apart in the row or, where it is desired, the crowns may be set four feet by four feet.

Cultivation.—Plenty of cultivation should follow the planting and the weeds should be kept down. All seed stalks should be broken off as soon as they appear.

Harvesting.—The crop should be allowed to grow for two years before being harvested heavily. It is best to harvest only lightly during the third year as well. After that the crop should not be pulled too late on into the season, since the leaves and stalks are needed by the plant to produce food. Rhubarb stalks are pulled by a side-twist, pulling the largest stalks as they mature. In order to avoid wilting of the stalk it is well to cut off the leaves as soon as the stalk has been pulled.

Forcing Rhubarb.—Two-year-old roots from a healthy, well-grown plantation are dug in the late fall and stored in a place convenient to the forcing cellar. Usually the roots are allowed to freeze, and in order to facilitate removing them to the cellar it is well to spread a little dry straw between the layers of roots when being piled.

When forcing operations are started the roots are brought into the cellar, set on the floor, buds up, packed closely together and filled around with soil or sand which is kept moist thereafter. Any sort of cellar is satisfactory providing the proper temperature may be maintained and provision may be made to prevent direct light from entering. A temperature of 58° F. to 60° F. will not give as quick results as a higher temperature, but will give a crop which bears over a longer period. Steady temperatures are desired. Over the windows heavy brown paper should be placed or else we may get green colouring instead of the desired red colouring of forced rhubarb.

When rhubarb forcing is carried on extensively a new bed is set out each spring, using stock left in the ground the previous fall from the plot lifted for forcing. The spent roots, after forcing, are considered to be of little or no value and not worth saving. Pull the stalks as soon as fit, being careful not to leave small pieces of the stem remaining on the root. The stalks are tied in bunches of from three to five or six.

SALSIFY

Vegetable oyster is the name often applied to this plant on account of its use in making mock oyster soup. The vegetable may be used in different ways when cooked and is a crop deserving of wider use in the home garden.

Culture.—The plant belongs to the deep-rooted type of vegetable crops and, for best results, requires a deep, rich, loamy soil. It requires a long growing season and in general its requirements and culture may be given as being similar to those for the parsnip crop. The plants are thinned to stand two to three inches apart in the row.

Harvesting may be done in the fall and the roots stored in the cellar in sand, or the crop may be left in the ground and harvested in the spring.

For marketing, the leaves are cut off to within two to three inches of the crown, the roots washed and trimmed and bunches of six to twelve roots are made.

SPINACH

Probably there is more spinach grown for greens than any other such crop. It is grown in large quantities by market gardeners as both a spring and fall crop. It is also a popular early crop in the home garden.

Soil.—Any good soil will grow a crop of spinach, but a sandy loam is preferred for the early spring crop. A good spinach soil should be well drained, but fairly moist and rich in plant food. Muck soils are used for this crop in some parts.

Manure and Fertilizers.—In order to retain the humus supply of spinach soils some form of manure is needed. If barnyard manure is available it is best applied with some preceding crop unless it is very well decomposed.

Commercial fertilizers are used quite extensively with spinach in many sections. Where a complete fertilizer is used, one high in nitrogen is favoured, with only moderate amounts of the other two elements being present. If plenty of manure is available it would appear that the addition of a fair application of phosphorus with, perhaps, a little potash in addition to form two to four light applications of nitrate of soda (150 to 200 pounds per acre) should give good results.

Planting.—In the spring, seed is sown as early as possible in rows twelve to sixteen inches apart, using anywhere from sixteen to thirty pounds of seed per acre. For the fall crop the seed is sown from the latter part of August on into early September.

The plants are thinned to stand about four to six inches apart if thinning is necessary.

Clean, shallow cultivation is carried out until the crop is well grown.

Harvesting.—The harvesting of the crop starts when the plants are small, with about six leaves, and is continued until the plants commence to shoot to seed.

The tap root is cut just below the lower leaves and if necessary some trimming is done to remove dead leaves, etc.

The crop is marketed in well ventilated baskets, crates, hampers, or barrels, and should be clean and free from dirt and grit.

SQUASH

The squash crop is of more importance to commercial and amateur gardeners than is the pumpkin crop. Several varieties of squash are grown to meet the demand of consumers, including both summer and winter sorts.

Culture.—Cultural requirements are practically the same as those given for the pumpkin crop and resemble closely the requirements outlined for cucumbers and musk melons.

Varieties.—Summer squashes include the White Bush scallop type and the Yellow Bush, also the Crooknecked type. Of the winter squashes, the Warted Hubbard, Golden Hubbard, Boston Marrow, Delicious and Des Moines are popular representatives.

SWISS CHARD

Chard, as it is called sometimes, is a very useful plant for greens. The leaves are prepared and used like spinach and frequently the stalks are cooked and served similarly to asparagus. Like spinach it may be canned also and, since it will withstand hot weather better than most crops, it deserves a greater use in the home garden.

Culture.—The crop is an easily grown one and seed may be started indoors, later setting out the young plants, or it may be sown in the garden. Fifteen to eighteen inch rows are made, or wider for horse cultivation, and the plants are thinned to stand from eight to twelve inches apart.

Good, rich garden soil, supplemented with 600 to 800 pounds acid phosphate per acre and two or more light applications of nitrate of soda should produce a good crop.

Harvesting.—The outer leaves, while still tender, are cut almost back to the crown, using a sharp knife for the purpose. Care should be used to avoid injuring the bud.

TOMATO

Not only is the tomato one of the most popular and widely used vegetables, but it is, as well, recognized as being one of the most valuable from a medicinal point of view.

Tomatoes are grown extensively as a truck crop, as a market garden crop and in the home garden. There is also a large acreage grown annually for canning purposes. Bulletin 308, published by the Ontario Department of Agriculture, deals in detail with the growing of the outdoor commercial crops of tomatoes and may be had free of charge on application.

Soils.—The tomato appears to do well on a wide range of soil types. However, for the early crop light sandy or gravelly loams are preferred, while for a heavy yielding, later crop, rich, sandy loams and clay loams are favoured.

Fertilizer and Manures.—General recommendations at best can only be a guide for the use of fertilizers and manures with this crop. The character and treatment of the soil, along with what may be the ultimate use of the crop, together with the length of season for the district, all help to suggest what treatment is needed.

It is generally recognized that the tomato crop needs land in a high state of fertility to show good returns. Fresh manure is not advisable to be applied directly preceding the crop, rather should it be applied the previous fall or with a preceding crop. Tomatoes do well after a clover crop ploughed under the previous fall.

Of the commercial fertilizers, those bearing relatively high quantities of available phosphorus are most generally satisfactory. Under practically all conditions such a fertilizer applied in accordance with other conditions will prove beneficial.

Sometimes a light application of nitrate of soda is found useful just when early plants are getting a start after being set out in the open. However, since early fruiting and ripening is important with this crop, too much nitrogen is undesirable in that it prolongs growth at the sacrifice of fruiting.

A well-grown early tomato plant at the proper stage for setting out into the field.

Growing Plants.—For the early crop, seed is sown indoors during late February and early March. The plants are transplanted once, twice and three times, according to the method the grower uses. Pots, berry boxes, and flats are used and good plants are grown with all methods. Bulletin No. 308 describes this in detail.

The late crop and canning crop is started either in greenhouses or in hot-beds and in most cases is transplanted once to about two or three inches apart each way.

The truck grower or market gardener knows what is a good, well-grown type of tomato plant for setting out into the field for an early crop, but many small gardeners are sold soft, spindly, weak plants, that become checked badly and never fulfil the expectations of their grower. A good plant should be stocky and sturdy, well-rooted and with plenty of foliage. It should have been well hardened-off before being sold or set out into the field. When a plant is hardened-off its colour is not a bright, soft green of a tender plant and it is much better able to withstand the shock resulting from the change into its new conditions.

Planting.—Tomato plants are tender and should not be set out into the field until after danger from frost is over. Previous to setting out they should be well watered and as much of the soil and roots should be removed with the plant as possible. It is well to choose a dull day or else delay planting until late afternoon.

The most common distance of setting the plants is four by four feet. However, variations may be made either way. Various methods are in use in setting out the plants—some growers plough out furrows, others mark their fields and dig holes, while the most common method with the small grower is to use a trowel in setting the plants.

It is usually best to set plants somewhat deeper than they were growing in the pot or box and this is especially the case if the plant is long and leggy.

Firm the soil well around the roots of the plant, this is important.

Cultivation.—Cultivation should be given frequently and all weeds kept down. As the plants develop the cultivation should become more shallow and finally cease when injury to the roots is noticed.

A system of growing staked tomatoes in use by Massachusetts growers.

Growing Staked Tomatoes.—Many commercial growers produce a crop of tomatoes trained to a single stem and supported by stakes. This is an excellent way to handle the crop in the home garden.

Training.—Plants may be set from twelve to eighteen inches apart in rows three to four feet apart, or two rows of plants twelve to eighteen inches apart each way, with a four-foot width between the next two rows, may be set out.

Stakes of wood or iron may be used to support the plants or the plants may be trained to upright wires or to cross wires. Raffia is the usual tying material used and a loose loop is made about the stem and attached to the support. Three or four ties will prove sufficient.

Pruning.—In order to produce a single stemmed plant the side shoots and suckers which develop must be kept pinched out. Most of these suckers will develop in the axils of the leaves.

Harvesting and Marketing Tomatoes.—If allowed to ripen on the vine, tomatoes will have a better flavour than when pulled green. Eleven-quart baskets are most in use in packing and marketing the crop and when shipped, only firm, sound, well-graded, clean fruits should be packed.

TURNIPS

This crop is grown more or less by market gardeners and to some extent in the home gardens. It is what the average householder refers to as summer turnips or white turnips, and differs from the so-called winter turnip or rutabaga. This latter crop is grown largely by general farmers as a field crop of which large quantities find their way into city markets.

Soils.—A deep, rich, well-drained loam is a very good turnip soil. Thorough preparation of the soil is advisable.

Fertilizer and Manure.—Much the same treatment as suggested for beets would be suitable for the turnip crop. Very little potash and more phosphorus and nitrogen state the needs of this crop.

Planting.—The turnip is a cool weather crop and does best, usually, as a fall or early spring crop. Seed is sown in drills fifteen inches apart in the garden and the plants later thinned to about six inches apart. Cultivation recommendations are similar to those given for beets.

Rutabaga cultural requirements are similar, only this crop requires a longer period of growth in order to mature large roots.

WATERCRESS

This is a salad plant that grows naturally in abundance throughout this province along the edges of streams, but is often cultivated. It will thrive on almost any moist soil. Pieces of the stem are used for propagating the plant and only need to be placed in contact with the soil. Seed is also used to establish beds. Where a stream or ditch is used for a bed, the bed once established and providing good clean water is present will remain indefinitely.

WATERMELONS

The watermelon crop in this province does not occupy a place of any great importance. Most of the watermelons sold are imported from the Southern States. However, in the earlier sections of Ontario watermelons may be grown quite successfully as a crop.

Soil.—A light, early, well-drained soil in good tilth is desired for watermelons. It should be well supplied with plant food, though an excess of nitrogen is to be avoided, since it tends to make too much vine growth. Rotation of this crop is necessary for successful results.

Planting.—Seed may be started under glass as for muskmelons or may be sown directly in hills eight to twelve feet apart, sowing seven or eight seeds to the hill and later thinning the young plants to three or four in number.

Cultivation.—Cultivation should be continued until the vines cover the ground.

Harvesting.—Experience alone can prove the guide as to when a watermelon is ripe. When the white spot, where the fruit rests on the ground, turns yellow and rough, or when the melon on being struck sounds dull and heavy and does not ring hollowly, are two pretty good indications of ripeness.

VEGETABLE VARIETY LIST

Artichoke	White (Jerusalem), Green Globe.
Asparagus	Reading Giant, Mary Washington.
Beans	Dwarfs—green snap—Valentine, Refugee.
	" —shell—Bush Lima (Fordhook).
	" —yellow or wax—Early Stringless Wax, Golden Wax, Wardell's Kidney Wax.
Beets	Flat Egyptian, Detroit Dark Red.
Broccoli	Walcheren.
Brussels Sprouts	Dalkeith.
Cabbage	Early—Jersey Wakefield, Golden Acre, Copenhagen Market.
	Main Crop—Glory of Enkhuizen, Short Stem Ball Head.
	Savoy—Green Globe Savoy. Red—Red Rock.
Carrots	Chantenay, Danvers, Early Scarlet Horn.
Cauliflower	Extra Early Erfurt, Snowball, Danish Perfection.
Celeriac	Large Smooth Prague.
Celery	Early—Paris Golden Self Blanching (new), Golden Plume.
	Fall and winter—Paris Golden Self Blanching (old), Easy Blanching, Giant Pascal, Winter Queen.
	Red—London Prize Red.
Chives	Common.
Citron	Colorado Preserving.
Corn	Early—Golden Bantam, Early Cory, Malcolm.
	Main Crop—Stowell's Evergreen.
Cucumber	White Spine, Chicago Pickling (improved).
Dandelion	Improved Cabbaging.
Egg Plant	Black Beauty.
Endive	White Curled, Batavian.
Horse Radish	Bohemian.
Kale	Dwarf Scotch (green curled).
Kohl Rabi	Early White, Purple Vienna.
Leek	Carentan, London Flag.
Lettuce	Leaf—Grand Rapids.
	Head (crisp)—Hanson New York, Iceberg.
	Head (butter)—Big Boston, May King.
Muskmelons	E.E. Osage, Sugar Sweet, Lake Champlain, Bender's Surprise.
Mustard	English White.
Onion	Seed—Southport Yellow Globe, Southport Red Globe, Danvers, Yellow Globe, Red Wethersfield.
	Pickling—Silver Skin, Barletta.
	Green—White Welsh, Egyptian.
	Transplanted—Prizetaker, Riverside Sweet Spanish.
Parsley	Champion Moss Curled.
Parsnip	Hollow Crown.
Peas	Early dwarf—Alaska, Surprise.
	Mid-season dwarf—Gradus, Thos. Laxton, Am. Wonder.
	Later dwarf—Telephone.
Potatoes	Early—Early Ohio, Irish Cobbler.
	Main Crop—Green Mountain, Dooley.
Peppers	Ruby King, Chinese Giant, Sunnybrook Tomato, Red Cayenne.
Pumpkin	Pie, Connecticut Field.
Radish	Early—Sparkler White Tip.
	Summer—Chartier, Icicle.
	Winter—Long Black Spanish, China Rose, Long White Spanish.
Rhubarb	Victoria, Linneaus, Sutton's Seedless.
Salsify	Mammoth Sandwich Island.
Spinach	Early—Viroflay, King of Denmark.
	Fall—Victoria, Virginia Savoy.
Squash	Summer—Vegetable Marrow, Crookneck.
	Winter—Warted and Golden Hubbard, Boston Marrow, Bush Marrow, Kitchenette.
Swiss Chard	Giant Lucullus.
Tomato	Red—Earlianna, Bonny Best; Pink—Globe.
Turnip	Early—White Milan, Purple Top Milan.
	Late—Golden Ball, Swedes.
Watermelon	Cole's Early.

NUMBER OF PLANTS REQUIRED PER ACRE AT VARIOUS DISTANCES.

1 inch	x 10 inches	627,279	18 inches	x 2 feet	14,520
1 "	x 12 "	522,720	18 "	x 30 inches	11,616
2 inches	x 10 "	313,632	18 "	x 3 feet	9,680
2 "	x 12 "	261,360	18 "	x 4 "	7,260
3 "	x 12 "	174,240	18 "	x 5 "	5,804
4 "	x 12 "	130,680	2 "	x 2 "	10,890
6 "	x 12 "	87,120	2 "	x 3 "	7,260
12 "	x 12 "	43,560	2 "	x 4 "	5,445
12 "	x 15 "	34,848	2 "	x 5 "	4,356
12 "	x 18 "	29,040	3 "	x 3 "	4,840
12 "	x 25 "	21,780	3 "	x 4 "	3,630
12 "	x 30 "	17,424	3 "	x 5 "	2,904
12 "	x 3 feet	14,520	4 "	x 4 "	2,722
12 "	x 4 feet	10,890	4 "	x 5 "	2,478
15 "	x 18 inches	23,252	5 "	x 6 "	1,452
15 "	x 2 feet	17,424	6 "	x 6 "	1,210
15 "	x 3 "	11,619	6 "	x 7 "	1,037
15 "	x 4 "	8,712	6 "	x 8 "	907
15 "	x 5 "	6,969	7 "	x 7 "	888
17 "	x 20 inches	17,424	8 "	x 8 "	680

QUANTITY OF SEED REQUIRED FOR VARIOUS CROPS.

ASPARAGUS.—1 oz. to 100 ft. of drill; 2 lbs. will provide roots for 1 acre.
BEANS.—1 pint to 100 ft. drill; 1¼ bus. per acre.
BEET.—1 oz. to 50 ft. of row; 4 lbs. per acre.
BRUSSELS SPROUTS.—¼ oz. to 100 ft.
CABBAGE.—1 oz. to 300 ft. of drill; 1 oz. produces 2,000 to 2,500 plants; 1 lb. seed outdoors, 20,000 to 30,000.
CARROT.—½ oz. to 100 ft. drill; 2½ lbs. to acre.
CAULIFLOWER.—1 oz., 2,500 plants.
CELERY.—⅓ oz. per 100 ft. drill; 1 oz. produces 10,000 plants.
CORN.—¼ to ½ pint to 100 hills; 1 peck per acre.
CUCUMBERS.—1 to 2 ozs. to 100 hills; 1 to 2 lbs. per acre.
EGG PLANT.—1 oz. produces 2,000 plants.
ENDIVE.—¼ oz. to 100 ft. of drill; 4½ lbs. per acre.
KALE.—1 oz. to 300 ft. of drill.
KOHLRABI.—1 oz. to 300 ft. of drill; 4 lbs. per acre.
LEEK.—1 oz. to 100 ft. of drill; 4 lbs. per acre.
LETTUCE.—¼ oz. to 100 ft. of drill; 3 lbs. per acre.
MELONS (Musk).—2 oz. per 100 hills; 4 x 4 ft.; 2 lbs. per acre.
ONION SETS.—1 quart to 50 ft. drill; 8 bus. per acre.
PARSLEY.—½ oz. to 100 ft. of drill; 3 lbs. per acre.
PEAS.—1 to 2 pints to 100 ft. drill; 1½ to 2½ bush. per acre.
PEPPER.—1 oz. produces 1,500 plants.
RADISH.—1 oz. to 100 ft. row; 10 to 12 lbs. per acre.
RHUBARB.—1 oz. seed to 125 ft. drill; 3½ lbs. per acre.
SALSIFY.—1 oz. seed to 100 ft. drill; 8 lbs. per acre.
SPINACH.—1 oz. to 100 ft. of drill; 5 to 6 lbs. per acre, in drills; 30 lbs. per acre broadcast.
SQUASH.—8 oz. to 100 hills.
TOMATO.—1 oz. produces 2,000 to 2,500 plants.
TURNIP.—1 oz. to 200 ft. of drill; 1 to 2 lbs. per acre.

PLANTING TABLE

This Planting Table for Vegetables is based on results in District of Toronto. Local conditions will vary this to some extent, either earlier or later.

Vegetable.	Seeds or plants necessary for 100 ft. of row.	Time for planting out of doors.	Depth to plant.	Distance between rows.		Distance between plants in rows.	Time to harvest.
				Horse cultivation.	Intensive cultivation or for amateur garden.		
Artichokes	10 lbs.	April	3 in.	3–4 ft.	3 ft.	3 ft.	Frost.
Asparagus, seed	1 ounce	April, May, June	½ in.	3 ft.	3 ft.	3–5 in.	
Asparagus, plants	50 plants	April, May, June	6 in.–9 in.	5 ft.	5 ft.	18 in.–2 ft.	May 1st
Beans, bush	1 pint	May, July	1½–2 in.	2½ ft.	2 ft.	4–6 in.	July 1st
Beets	2 ounces	May, July	½ in.	2 or 2½ ft.	1–1⅓ ft.	3 in.	June 15th
Brussels Sprouts	¼ ounce	May	¼–½ in.	2½–3 ft.	1½–2 ft.	2 ft.	Sept. 15th
Cabbage, early	¼ ounce	April, May	¼–½ in.	2½–3 ft.	2–2½ ft.	18 in.–2 ft.	July 2nd
Cabbage, late	¼ ounce	June to July 12	¼–½ in.	3 ft.	2½ ft.	2–2½ ft.	October
Carrot	½ ounce	April, May, July	¼–½ in.	2 ft.	16 in.	2–3 in.	July 1st
Cauliflower	¼ ounce	April, July 12	¼–½ in.	2½–3 ft.	2–2½ ft.	1½–2 ft.	Aug. 15th, frost
Celery	¼ ounce	May 15, July	1/8 in.	3–5 ft.	1½–3 ft.	6–8 in.	Aug. 15th, frost
Citron	1 ounce	May, June	1 in.	6–8 ft.	6 ft.	4–6 ft.	Aug. 15th, frost
Corn, sweet	¼ pint	May, July	2 in.	2½–3 ft.	2–2½ ft.	2–3 ft. (hills)	Aug. 1st
Cucumbers	½ ounce	June, July	1 in.	6 ft.	4 ft.	1 ft. or 6 ft. hills	Aug. 1st
Egg Plant	⅓ ounce	June	½–1 in.	2½–3 ft.	2–2½ ft.	1½ ft.	August
Kale or Borecole	¼ ounce	May	½ in.	2½–3 ft.	1½–2 ft.	1–2 ft.	Frost
Kohl-rabi	¼ ounce	May, June, July	½ in.	2–2½ ft.	1½–2 ft.	6 in.	August 15th
Leeks	½ ounce	April	½–1 in.	2–2½ ft.	1–1½ ft.	2–4 in.	Aug. 15th, frost
Lettuce	¼ ounce	April, May, June, Aug.	¼ in.	2 ft.	1–1½ ft.	4–6 in.	June 1, all season
Melon, musk	½ ounce	June	1 in.	6 ft.	6 ft.	12 in.–6 ft. hill	Sept. 1st
Melon, water	1 ounce	June	1 in.	7–9 ft.	4–6 ft.	4–6 ft.	Sept. 15th
Onion, seeds	½ ounce	April	½–1 in.	2–2½ ft.	1–1½ ft.	8 plants to 1 ft.	Sept. 1st
Onion, sets	2 qt. sets	April	1–1½ in.	2–2½ ft.	1–1½ ft.	1 in.	June 1st
Parsley	¼ ounce	April, May, August	¼ in.	2–2½ ft.	1–1½ ft.	2–4 in.	July 1st
Parsnip	1 ounce	April, May	½–1 in.	2–2½ ft.	1½–2 ft.	3–4 in.	Aug. 15th, frost
Peas	1 quart	April, May, July	2–3 in.	2½–3 ft.	2 ft.	½ in.	July 1st
Pepper	½–1 ounce	June	½ in.	2–2½ ft.	1½–2 ft.	15–18 in.	Sept. 1st
Potato, Irish	10 lbs.	April, May	4 in.	2½–3 ft.	2–2½ ft.	9–15 in.	July 15th
Pumpkin	½ ounce	June	1–1½ in.	6–8 ft.	6–8 ft.	6–8 ft.	Sept. 15th, frost
Radish	1 ounce	April, September	½ in.	2–2½ ft.	6–12 in.	½–1 in.	May 15th, frost
Rhubarb, plants	33 plants	April, May	2–3 in.	4 ft.	3 ft.	3 ft.	May 1st
Salsify	1 ounce	April, May	½ in.	2–2½ ft.	1½–2 ft.	2–4 in.	Sept. 1st
Spinach	1 ounce	April, August	½–1 in.	2–2½ ft.	6–12 in.	1 in.–2 in.	June 1st
Squash, summer	½ ounce	June	1½ in.	3–4 ft.	3–4 ft.	3 ft.	July 15th
Squash, winter	½ ounce	June	1½ in.	7–9 ft.	7–9 ft.	3–4 ft.	Aug. 15th, frost
Tomato	25–50 plants	June	3–4 in.	3–5 ft.	1½–2 ft.	3 ft.–4 ft.	July 15th, frost
Turnip	½ ounce	April, August	¼–½ in.	2–2½ ft.	1½–2 ft.	4–6 in.	Sept. 1st.

An up-to-date vegetable garden. Note the straight rows and the arrangement of the crops.

Ontario Department of Agriculture

HORTICULTURAL EXPERIMENTAL STATION
VINELAND STA., ONT.

CA2ØNAF
B315

Plum Culture in Ontario

INTRODUCTORY

The plum is one of the oldest of cultivated stone fruits. There are records to show that, in one or more forms of its various species, it has been cultivated for many centuries. The Greeks and Romans grew this fruit before the Christian era and it is said to have been grown by the ancient Lake Dwellers of Switzerland. It is also one of the most widely distributed of temperate zone fruits, being found native throughout the temperate regions of Europe, Asia, Australia and the Americas.

The plum is a member of the genus *Prunus*, a plant division which includes peaches, almonds, cherries and apricots. According to Hedrick, in Plums of New York, there are twenty-four distinct species of plums and over two thousand varieties. Of these various species only four or five are as yet of much importance, and of the large number of varieties comparatively few are of value to the Ontario fruit grower. Our best varieties are European importations or offshoots from them, and we have not a single variety evolved from our native American species that is equal to them. The Japanese varieties are importations, or have been produced from imported stock, and as yet not a single variety has been produced that has maintained a permanent hold on the public—a hold equal to that of the Reine Claudes, Prunes and Damsons.

SPECIES COMMONLY GROWN

In order to more thoroughly understand the discussion later it might be well to outline a classification that covers the common varieties. Each class requires somewhat special treatment or care, and it is well at the outset to make mention of them.

Prunus Americana includes nearly all our best native varieties. These are not grown largely in commercial orchards, but are found in many gardens throughout the Province. Some of the principal varieties are De Soto, Hawkeye, Stoddard and Wolf. One other variety that is very similar to the above is Cheney, but this is a distinct species (*Prunus nigra*). The native plums are very hardy but are not widely grown because of the astringent nature of the fruit. Their hardiness, however, makes them desirable for those sections where other better species cannot be grown. In such sections they seem to be gaining in favour as they make jams of very superior quality.

Prunus Domestica includes nearly all our best varieties, those that have been imported direct from Europe or developed from the importations. Some of the leading varieties are Monarch, Grand Duke, German Prune, Italian Prune, Reine Claude, Green Gage, Washington, Lombard, Bradshaw and Glass Seedling. The domestica plums are superior in quality of fruit to the Asiatic or American

species but are not adapted to such a wide range of soils or climates as the latter species.

Prunus Triflora (or *Salacina*) includes the Japanese varieties, those that have been imported from Japan or developed here from the importations. Abundance, Burbank, Red June, Willard are some of the better-known varieties. Shiro, though a hybrid with other species, may be included in this group because of its triflora characteristics. The Japanese plums are generally quite productive and many varieties are vigorous growers, but the fruit is usually of medium quality only.

Prunus Insititia includes the Damsons, the most important of which are the Common Damson and Shropshire Damson.

PROPAGATION

Plum trees used in the commercial orchards of Ontario are grown almost entirely by the local nursery firms. A few are imported from the United States, but a large percentage are home-grown.

Seedling stocks (Myrobalan) are obtained from France in the winter and planted in the nursery rows the following spring. At one time St. Julien stocks (*Prunus insititia*), a species of Damson, were used almost entirely by the nurserymen of the Eastern United States, but they have given way for the Myrobalan (*Prunus cerasifera*). It is generally admitted, however, that domestica and Damson plums make better trees, thrive better and live longer on St. Julien than Myrobalan, and there are to-day many orchards on this stock in the State of New York. For the colder parts of Ontario where the Americana varieties are grown seedlings of the native species are used as stocks.

The nurserymen prefer the Myrobalan stock because it gives a larger and thriftier tree in one year, and is easier to bud successfully. Also it is less subject to disease, and it costs less than St. Julien. Naturally, then, under these conditions the nurseryman is going to use the stock that gives the best growth while in the nursery and which can be sold at the most reasonable price.

The seedling stocks planted in spring are budded the summer immediately following (August), and sold a year from the following spring as yearling trees, or sold two years from the spring following the bud, as first or second-class trees of standard sizes according to grade.

The stock may be dug either from the nursery row in the fall and heeled in a dry place near the buildings, or, what is most generally the practice, and the best practice, tied in bundles and piled in the storage houses, where they are held at a low temperature to prevent any starting of the buds. Heeling in is also practised sometimes in the storage cellars, but requires a vast amount of space. Undoubtedly nursery stock handled in this manner comes through the winter's storage in better condition than if piled in bundles with roots practically unprotected. In a few cases trees are left all winter in the nursery row. Such a practice cannot be recommended for spring delivery, though the stock itself would be in excellent condition.

In winter the trees in the storage are sorted into sizes or grades and with the opening of spring are packed for delivery.

The larger trees are in greatest demand, but medium sizes, and especially the good grades of clean, straight stock of one- and two-year-old trees are to be preferred. One-year-old stock of the rapid-growing Japanese varieties is recommended. The Reine Claudes and similar types are slower growers, and are much smaller than the Japanese varieties at one year. Two years are required for these to attain commercial size.

SOILS

Plums are adapted to a wide range of soils, but like most other fruits have a preference. The domestica or European plums are best suited to clays and clay loams. They will thrive on sands and heavy clays, but the largest and most regular yields of the highest quality fruit seem to be found on clays and clay loams. It is sometimes stated that plums will thrive on wet soils, but in the main the statement is incorrect. They will thrive under damper soil conditions than the peach or cherry, but it does not follow that such a soil is wet. Warm-bottomed lands are as much preferred by plums as by any other fruit, but they will maintain their vigour under more adverse conditions.

The Damsons are well adapted to a little greater variation and will thrive to the fullest degree on the heavy clays. Japanese plums, on the other hand, though also adapted to a wide range of soils, may be expected to yield highest returns on the lighter soils. Many of these species are worked on peach roots—especially in the South, and in such cases are adapted to soils that favour that particular fruit. The Americana and Nigra groups will do well on both clay and sandy loams but generally should be planted on the lighter soils in northern sections.

Soils, generally speaking, are not as important as the drainage of the soil. If the subsoil is sufficiently open to permit of an extensive development of the root system; if it dries off readily in the spring or after a heavy rain; if it is sufficiently open to permit of easy drainage and at the same time holds moisture well under judicious management, be it sand or heavy clay, it is adapted to fruit trees, and plums will thrive on it. It is a mistake to put plums where no other fruit would grow. Poorly drained soils do not warm up as early in the spring as well-drained soils. This limits the season and the amount of growth, retards the ripening period, reduces the yield, and is conducive to other troubles such as winter injury. All soils that are not naturally well drained should, therefore, be thoroughly underdrained.

There is no objection to a large number of stones in the soil, provided they do not interfere with cultivation, as such a soil is usually open and quite fertile.

The above statements will arouse this question: If plums are only a fair investment, and do not pay as well as some other fruit, why should we not reserve the good soil for the better-paying fruit? By all means put the plum orchard on the heavier and cheaper land, but only if that cheaper land is adapted to them. Drain it, and fertilize and cultivate it and the plums will respond as readily as any other fruit. Plant them under the best conditions possible in your particular circumstances.

SITE

The site for the plum orchard is generally largely determined by the soil factor. Other factors are, however, of importance, notably elevation and slope.

Elevation of Site.—The experience of growers and the observations of those who have made a study of the principles underlying fruit growing, indicate that a site having some elevation above adjacent areas is preferred for a plum orchard, or indeed for most fruits. This is due to the fact that trees on elevated areas are less likely to be damaged by late spring frosts than trees on the lower levels. It is a well-known fact that cold air settles to the lower levels, and thus the temperature in a hollow, especially where pockets occur, will be lower than on the higher slopes nearby. In some cases this difference amounts to several degrees, thus accounting for frost injury in low places while the higher areas escape.

In most parts of the Niagara fruit district there is a gentle gradual slope from the base of the escarpment to the bank of Lake Ontario and then a decided drop to the water level. This provides excellent air drainage and furnishes relative immunity against damage from late spring frosts.

Good air drainage is also a factor in controlling those diseases that attack the fruit. Brown rot of stone fruits is always more difficult to control where there is little air movement. The rot spores cannot thrive under dry conditions, and the freer the air circulation the less rot there will be. Do not hide the trees behind a woods or thick hedge, or place in a basinlike hollow where it is not possible to have a free circulation of air. The orchard should be as much in the open as possible without undue exposure to heavy winds.

Slope.—A gentle, gradual slope in some direction is better adapted to tree fruits than a site that is flat. This is because of the better air and soil drainage, the importance of which have already been noted, rather than to the effect of any particular slope on the growth of the tree. In other words, the direction of the slope is not so important as the slope itself. However, it is commonly believed that a northern slope is best. If a northern slope has any merit over other slopes it is probably due to the greater immunity from sunscald which certain varieties show in contrast to the amount of sunscald on the same varieties grown on marked southern slopes.

Trees on northern slopes are also later in coming into bloom than trees on southern slopes and hence may in some measure escape damage from late spring frosts. This is particularly true of the Japanese varieties, which blossom earlier than other species. In choosing a site for these varieties a northern slope should therefore be given the preference where there is an opportunity of choice.

PLANTING

The following paragraphs dealing with the various factors incidental to setting out the orchard are applicable to any tree fruit and are therefore given in some detail.

Preparation of Soil.—Experience has amply demonstrated that newly planted fruit trees will get away to a better start and generally do much better when the soil is moderately fertile and in good physical condition. To attain this ideal the preparation of the soil should begin at least one year, and preferably two years, before the orchard is to be planted. An economical and satisfactory method of soil preparation is to grow a hoe crop such as tomatoes, potatoes, sweet corn, beans, etc., during the season preceding the planting of the trees. The soil for these preparatory crops should be thoroughly enriched by good applications of stable manure or by plowing under green crops such as red clover, sweet clover, vetch or other suitable green manuring crops. This method of enriching the soil will not only supply the necessary plant food for the preparatory crops but will leave the soil in a good physical condition for the trees. After the preparatory crops have been removed the land should be plowed and thoroughly prepared for the planting of the trees.

Selection of Stock.—Opinions differ as to the age of trees most suitable for planting. Some prefer one-year trees, others two-year. Probably the age of the tree is not so important as its condition. A good, strong, well-grown, one-year tree, especially of the Japanese varieties, or a medium-sized, well-rooted two-year-old tree, will both be quite satisfactory. Overly large two-year trees are more difficult to transplant and are not likely to make as good a start as medium-sized trees of the same age. On the other hand, weak, stunted specimens with poor root systems should not be planted, as they invariably grow slowly and make poor trees.

Spring and Fall Planting.—The planting of the nursery stock may be done either in the fall or spring. Spring planting is the most popular time at present, but there is no reason why they should not be set in the fall, if well-matured trees can be obtained in late September or in October, or even later. The trees must be well matured for transplanting, and unless good well-ripened individuals can be obtained it is better to wait till spring. Ordinarily they can be obtained. Experiments conducted at Vineland with one variety, Reine Claude, over a period of three years, indicate that something is gained by fall planting. Six trees were planted in the fall of each of the years 1911, 1912, 1913, and in the spring of 1912, 1913, 1914. In every case the fall-planted trees show a greater growth; are more vigorous and thrifty. There is possibly a labour advantage in fall planting sometimes, but not always.

If the soil can be put into first-class shape and the trees obtained when ready it will pay to plant; otherwise wait till spring.

Treatment of Nursery Stock.—After the trees are received from the nursery they should be unpacked immediately and "heeled in" in a shady, well-drained spot convenient to the plantation. The term "heeling in" is used in reference to a practice of laying the trees temporarily in a trench and covering the roots with soil until ready to plant. A trench 12″ to 15″ deep and about 15″ to 18″ wide is quite satisfactory for this purpose. One side of this trench should be made with a slope to permit the trees being laid in at an angle. The trees are then spread out crosswise along this trench with the roots in the bottom and the trunks on the sloping side. The roots are then covered with soil, special care being taken to thoroughly sift in the soil between the roots so that no air spaces are left. Enough soil should be placed over the roots to prevent drying out. If the soil is at all dry it should then be thoroughly watered around the roots.

It is very necessary to keep the roots of trees protected from the sun and drying winds during all transplanting operations, as such exposure is quite injurious.

Planting Distances.—The distance apart to plant will naturally vary somewhat with the different varieties. Some are quick, vigorous growers and make comparatively large trees. Such varieties as, for example, Washington, Imperial, Glass, Bradshaw, etc., should not be planted closer than twenty feet square. Other varieties, as Damson, Italian, German, Lombard, may be planted eighteen feet each way. Where it is desired to plant a number of varieties, some of which are large growers and others small, the rows may be kept in straight lines and the trees an equal distance apart in the rows, but the rows brought closer together for the smaller-growing varieties.

Don't make the mistake of planting too closely. Just as much and better fruit will be produced at the greater distance and it will not all be in the tops of the trees. Moreover, close planting requires a greater number of trees to the acre, costs more to prune, spray, etc., and makes cultural operations more difficult.

Laying Out the Plantation.—Several methods may be used to lay out the orchard, any one of which will give good results if carefully done. Probably one of the simplest and best methods is by the use of a marked wire. Exactly parallel lines of stakes at a distance apart decided on for the trees are first set, one line on either side of the field. The wire marked at the proper distances, say twenty feet, is then stretched across the field from stake to stake, care being taken that the end marks and end stakes coincide. The wire should be attached to stout stakes which are then driven into the ground to hold the wire taut. Stakes are then driven in at each mark on the wire and the wire then moved for

the next row, etc. In using this method it is obvious that the wire must be stretched tightly each time and the end wire marks must coincide with the base stakes.

Planting the Tree.—After staking in this manner a planting board should be used to get the tree in the exact spot. A planting board consists of a strip of lumber 6 to 8 feet long, 6 inches wide and 7/8 inches thick. This is notched at the centre, and inch holes bored at either end to receive pegs. When ready to

Orchard showing the result of too close planting. 20 ft. x 20 ft. is a good average distance. The smaller growing varieties may be planted 18 ft. each way.

dig the hole for the tree the planting board is placed crosswise of the row, with the stake marking the position of the tree in the centre notch. Pegs are then placed in the end holes, the board is placed to one side and the hole dug. After digging, the planting board is put in place again, and the tree set in the hole

The hole should be made wide enough to accommodate the main part of the root system without crowding and deep enough to permit the tree being planted at least two inches deeper than it stood in the nursery row. In digging, keep the surface soil separate from the subsoil.

When ready to plant the tree some attention in the matter of root pruning is necessary. All broken or bruised roots should be cut back to the uninjured

tissue, and long slender roots shortened. In placing the tree in the hole the roots should be spread out, not bunched, and fine surface soil sifted in around them. Where the hole has been partially filled move the tree up and down slightly but quickly several times for the purpose of settling the soil in and around the roots. After this, and as filling in progresses, firm the soil well with the heel. Finally a loose layer of soil should be left on the surface as a mulch. Perhaps the most important point in setting a tree, and one which is often disregarded, is to have the soil *firmly* packed around the roots. Failure to do this often results in the death of the tree, or at least in poor growth.

POLLINATION

The question of pollination is important where large areas of plums are grown. Most varieties of plums, whether Japanese, Americana or Domestica, are self-sterile: that is, the varieties will not pollinate or fertilize themselves. Cross-fertilization is necessary.. The Damsons and some of the Domestica varieties are self-fertile, but even they are more likely to produce abundantly when cross-pollination is provided for. Japanese varieties are readily pollinated by Americana varieties that blossom at the same time.

A large block of Burbank or a large block of Abundance will not pollinate freely if isolated, but if the blocks are near each other or the rows mixed through, pollination will be almost certain. The same might be added with regard to Red June. The popular Americana varieties, De Soto and Hawkeye, are self-sterile, as is also the popular Nigra variety Cheney, but they all cross-pollinate readily.

The accompanying table summarizes two seasons' work on the fertility of various varieties of plums, all Domesticas with the exception of the Damsons. This work was carried on at The Horticultural Experiment Station during 1922 and 1923. With one or two exceptions from 500 to 1,500 blooms of each variety were covered for each season. In calculating the percentages of self-fertility, the set under conditions of open pollination was taken as 100 or normal, even though half or less of the total bloom actually set. If the calculation were on a total bloom basis instead of total normal set, the percentages of self-fertility would be very much lower and would give an incorrect idea of the degree of fertility. The varieties are arranged roughly in order of fertility, the most fertile at the top.

Variety	Normal Set per cent.		Self-fertility (Calculating normal set as 100 per cent.)	
	1922	1923	1922	1923
King of the Damsons....	24.03	76.33	45.98	94.34
Italian.....	42.43	51.72	86.04	73.79
Gueii.....	61.40	53.40	56.74	47.76
Lombard.....	62.22	81.20	17.24	43.86
Shropshire Damson.....	36.43	35.39	64.48	25.88
Grand Duke.....	18.58	29.66	.....	32.61
Peters Y. Gage.....	68.02	66.35	17.90	23.22
Yellow Egg.....	15.02	35.79	13.60	15.64
Monarch.....	37.03	24.30	21.00	10.66
Reine Claude.....	35.51	46.22	4.54	5.37
Duane.....	16.00	42.75	7.70	4.81
Arch Duke.....	17.93	9.3	.....	.....
Golden Drop.....	16.75	15.44	.....	.....
Hand.....	2.53	26.33	.....	.....
Imperial Gage.....	63.95	13.72	.....	.....
Washington.....	7.64	52.89	.....	.....

The normal set generally was heavier in 1923 than in 1922, due no doubt to weather conditions, or difference in the relative vigour of the tree, or both. In the same way the set of covered blooms was generally higher in 1923 than in 1922. Nevertheless certain fairly definite conclusions may be drawn. It is evident that Arch Duke, Golden Drop, Hand, Imperial Gage and Washington may be classed as completely self-sterile. Commercially Reine Claude and Duane also may be classed as self-sterile, though if the trees are in good condition, bloom is abundant and weather conditions favourable, sufficient blooms may set even in solid plantings to give a crop. However, none of these varieties should be planted in solid blocks of the one variety. Mixed plantings should be adopted.

Undoubtedly some of the other varieties listed, notably Grand Duke (self-sterile in 1922), Yellow Egg and Monarch should, for safety's sake, be planted with other varieties, not singly. The remaining varieties, including Italian Prune, Gueii, Lombard and the Damsons may be classed as sufficiently self-fertile to insure fair crops in solid plantings. Even with these varieties, however, it would be well to make assurance doubly sure by planting two or more varieties together. The bulk of the orchard may be of one variety. Cross-pollination can be insured by having every other tree in every other row, another variety of the same species blooming at about the same time. The Damsons and Domesticas seem to be interfertile, i.e., they will pollinate each other.

The blooming date of various varieties therefore becomes of importance. The date of first bloom, full bloom and falling bloom of all the varieties subsequently discussed in this bulletin, whether recommended varieties or otherwise, has been noted in The Horticultural Experiment Station orchard each year from 1915 to 1924 inclusive. These records show that in some seasons blooming may be irregular or protracted owing to disturbed and unfavourable weather conditions, and in such seasons there may be a difference of as much as four or five days in the date of full bloom of different varieties. For example, Reine Claude was in full bloom in 1915 on May 19th while Bradshaw did not reach full bloom until the 24th.

Generally, however, the records go to show that with the exception of the Italian Prune, which is a late bloomer, and the Japanese varieties which are early, the commercial Domesticas all fall in the class of medium season bloomers, and that they all reach *full* bloom within two, or at most three, days of each other. In other words, in normal seasons at least the blooming seasons of any two varieties will overlap sufficiently to insure cross-pollination if planted together. This is, of course, leaving out the question of intersterility within the Domestica group, which may be of some importance.

Of the exceptions noted, Italian has been shown to be self-fertile, cross-pollination therefore not being essential. The Japanese varieties, the other exception, should be interplanted with other varieties of their own kind, not with Domesticas, as, apart from the difference in time of blooming which is marked, the two species are intersterile or largely so. And, as previously noted, the self-sterility of the Japanese varieties necessitates provision for cross-pollination.

The question of the "June drop" might be taken up here. By this is meant the falling of a large number of fruits soon after the blossoms fall or even when the fruits are the size of beans, and in a few cases very much larger. The fruit turns yellow, shrivels up and falls off.

There are two main causes of this drop—poor pollination and attacks of Plum curculio. Pollination has already been fully discussed.

An examination of the fallen specimens will show that the curculio is also responsible for a large share of the damage. This can only be remedied by careful spraying and general tidy methods.

PRUNING

In the operation of digging a tree there is invariably a loss of a part of the root system. To restore the balance between top and roots and to properly head the tree, some pruning is necessary at planting-time. Where one-year trees are planted the top is cut back to a height at which it is desired to have the head formed. This will vary with the preference of the grower and the condition and variety of tree. As a rule tall, vigorous one-year trees are headed back more severely in proportion to their growth than smaller trees of the same age. The height of the head varies from 2½ to 3½ feet, according to the size of tree. As a result of this heading back several laterals will likely grow on the upper part of the tree during the first season. The best of these laterals are selected, in the spring of the second year, to form the foundation branches of the tree. Opinions vary as to the number that should be left for this purpose. Some growers hold that three are enough, while others believe that more are necessary. As a general statement there should be at least three and not necessarily more than five. In choosing these foundation branches care should be taken to select those that are evenly distributed around the horizontal axis of the tree and well spaced up and down the trunk.

These main scaffold branches are usually headed back as a means of getting additional branches where they are needed. The actual amount of cutting back will vary with the length and position of the branch. The upper branches of a tree usually tend to grow longer than the lower ones and therefore when heading in these laterals the lower laterals should be left longer than those at or near the top. In the second season of growth the primary scaffold branches are likely to produce several laterals. Two of the best of these on each of the main branches may be selected for the secondary branches and the remainder removed. In selecting these secondary branches care should be taken to choose those on the horizontal plane if possible and to leave some space between each lateral.

Where two-year trees are planted there are generally numerous branches already formed.

The selection and general treatment of these branches is much the same as for one-year trees in the second year of their growth.

The principal point to be considered in the initial pruning of a young fruit tree is to select those branches that will ultimately make a strong, well-balanced tree with an even distribution of fruiting wood around the circumference and throughout the head.

In actual practice it may be somewhat difficult to get the trees to conform to any well-defined scheme of training, and consequently the orchardist will have to take the tree as it is and work toward the above-mentioned ideal.

After the head has been formed, corrective pruning only is necessary until bearing age is reached. The heavy annual cutting back and thinning out of young trees, which has been practised so extensively in years past, serves no useful purpose, and in fact actually dwarfs the tree and delays fruiting. It is better to give the young, non-bearing tree too little pruning rather than too much, delaying the heavier cutting until bearing age.

The pruning of the bearing tree calls for somewhat different treatment. Sufficient pruning should be given to keep the tree properly open, and to encourage moderate new growth each year. The following suggestions will serve as a guide:

(1) Cut out broken, dead or diseased branches.

(2) Where two branches closely parallel or overhang each other, remove the least desirable, taking into account horizontal and vertical spacing.

(3) Prune on the horizontal plane, that is to say, leave those laterals on the main branches that grow horizontally or nearly so and remove those that hang down or grow upward. This cannot always be done, but where possible it should be followed.

(4) Close topped varieties such as Shropshire Damson or others of similar form should be thinned out enough to permit of thorough spraying, and the entrance of sunlight and air.

(5) Where it is desired to reduce the height of tall trees, cut the leader branches back moderately, to a horizontal lateral if possible.

(6) The lower branches of broad-headed or drooping varieties such as the Burbank should be pruned to ascending laterals.

(7) Varieties which tend to produce numerous twiggy, lateral growths should have some of these removed to prevent overcrowding.

(8) Make close, clean cuts. Stubs are unsightly and often decay, thus forming a source of injury to the parent branch or trunk.

(9) Prune moderately. Very heavy pruning is likely to upset the balance between wood growth and fruitfulness, and generally should be avoided.

(10) Prune regularly. Trees which are given some attention each spring are more easily kept in good condition than trees that are pruned irregularly.

(11) Do not remove a branch unless there is a very good reason for doing so. It should not be forgotten that the leaves of a tree are the food-manufacturing organs, and if the leaf area is reduced unnecessarily the tree will be injured in growth or fruitfulness or both.

SOIL MANAGEMENT FOR PLUM ORCHARDS

The system of orchard management which seems best adapted to plums is one known as clean cultivation and cover cropping. In this system the soil is cultivated at intervals during the spring and early summer and is then seeded to a cover crop of some kind.

Clean cultivation during the spring and early summer exerts many beneficial effects. These good effects are of course well known to the experienced fruit grower, but probably not so well known to the beginner. The following are some of the more important effects of spring and early summer cultivation:

(1) Warms and dries the soil in early spring.

(2) Supplies air to the soil and thus favours the activities of those micro-organisms that help to convert organic matter into plant food.

(3) Destroys weeds or grass which rob the trees of food and moisture. It also saves moisture by preventing evaporation through capillary action of the soil particles.

(4) Breaks up the breeding places of some insects and thus helps to hold them in check. It also tends to reduce plant diseases through burying infected leaves, fruit, etc.

(5) Helps to prevent injuries by mice and rabbits.

The general method of soil cultivation is to plow the soil in the late autumn or early spring. If plowing is done in the autumn the soil should be plowed toward the trees and not away. Plowing the soil away from the trees in the fall exposes the crown and roots and may predispose the trees to collar rot or root killing. Where biennial cover crops such as sweet clover, vetch, rye and red clover are grown it will of course be necessary to plow later in the spring, as these crops make their best growth in the spring. The time for turning under these cover crops will vary with seasonal conditions, soil and locality. Generally it will range from May 15th to 24th.

After the soil has been plowed it should be cultivated at intervals of a week until about the middle of July. After this date it is usually considered desirable to discontinue cultivation and sow a cover crop.

Cover Crops

Cover crops, like cultivation, exert many beneficial effects, the chief of which are noted below:

(1) Check late growth and thus help to prevent winter injury.

(2) Help to catch snow and indirectly serve to prevent deep freezing and root injury.

(3) Add humus forming material to the soil and thus help to keep the soil in good physical condition.

(4) Where leguminous crops are used nitrogen is added to the soil in one of the cheapest forms.

(5) Prevent erosion on uneven surfaces.

(6) Catch and hold soluble plant food.

Classes of Cover Crops.—Cover crops are generally classified as leguminous and non-leguminous. The leguminous group includes red clover, sweet clover, hairy vetch, cow peas, soy beans and horse beans. Of these, sweet clover, mammoth red clover and hairy vetch are the most widely used and probably the best. Sweet clover has given very good satisfaction and is now quite extensively grown. The seed can generally be purchased at a low cost, and a good germination is usually secured. It comes on early in the spring and makes a good growth before most other plants, thus permitting of plowing in before warm dry weather comes. The roots are large and penetrate deeply into the soil, keeping it open and friable.

In the non-leguminous class there are oats, rye, buckwheat, Japanese millet, turnips and rape. These crops are all well known and have been widely used as cover crops, and hence do not need more than a passing reference.

In the above list oats and millet have given very good results. Both of these crops make a fairly rank growth and furnish a lot of organic matter which can be turned under in the fall if desired. They are also killed by the first heavy frost and therefore do not take moisture from the trees late in the season.

Buckwheat is also a useful crop to sow, especially on heavy soils as a nurse crop for sweet clover. When sown as a nurse crop it should be allowed to come into bloom and then cut and left on the ground as a mulch.

Amount of Seed to Sow

	Amount per Acre
Leguminous:	
Sweet Clover	12-15 lbs.
Red Clover	10-12 lbs.
Hairy Vetch	1 bus.
Cow Peas	1½ bus.
Soy Beans	1 bus.
Horse Beans	1 bus.
Non-leguminous:	
Oats	1-1½ bus.
Buckwheat	3 pecks
Rye	1½ bus.
Turnips	6 lbs.
Rape	6 lbs.
Japanese Millet	2 pecks

When to Sow Cover Crops.—The time to sow cover crops is determined by soil and seasonal conditions. In warm dry seasons it is advisable to sow later than in seasons when there is an abundant rainfall, and on soils that are more susceptible to drouth sowings should likewise be later. As a general statement cover crops are sown about the middle of July.

Fertilizers

The fertilizer recommendations formerly made for fruits have been based largely on the plant food requirements of field crops, particularly cereals. These recommendations included the use of nitrogen, potassium, and phosphorus as essentials for the best results in growth and yield. Recently completed investigations, however, show that the food requirements of cereals and fruits are quite different and that the old recommendations are not entirely sound.

These studies show that nitrogen is very often the limiting factor in fruit soils. This element makes a vigorous growth of stem and leaf and is an important factor in the formation of fruit buds and in securing a good set of fruit. Nitrogen may be incorporated in the soil by the addition of stable manure, leguminous cover crops or by nitrogen bearing fertilizers. Where stable manure is readily available it should be used, not only for the nitrogen which it contains, but also because it furnishes organic matter to the soil. This organic matter decays and forms humus, which is the basis of soil fertility. Without the presence of humus, heavy soils will bake and become very hard in dry weather, and light soils will suffer more severely from drouth. The principal food requirements of plants, that is, nitrogen, phosphorus and potassium, may be in the soil in abundance, but without a good supply of humus the soil will not be fertile. In other words humus is the conservator of these important plant foods. Cover crops ultimately furnish humus when plowed under and may be used as a substitute for stable manure. As previously noted, when leguminous cover crops are grown nitrogen is restored to the soil through the action of nitrogen fixing bacteria which operate in the nodules on all leguminous plants. These plants are, therefore, more valuable than non-legumes and should be given the preference in the choice of cover crops.

The nitrogen requirement of plum orchards could in all probability be met by moderate applications of stable manure and the plowing under of legumes. If this treatment does not produce the desired results in growth or fruitfulness, commercial fertilizers such as nitrate of soda or ammonium sulphate should be used as a supplement. The quantity to use will be determined by the size and condition of tree. A general rule followed by some orchardists is to use one-quarter pound per tree for each year of its growth.

Phosphorus, or phosphoric acid as it is usually called, is present in most soils in sufficient quantities for the needs of tree fruits and therefore applications of this fertilizer are not likely to be of value to the trees directly. This element, however, often stimulates the growth of cover crops and, therefore, is of indirect value to the tree, in producing growth and fruitfulness. Where the growth of cover crops is not satisfactory, applications of phosphatic fertilizers such as acid phosphate, bone meal, or phosphate flour would probably be beneficial.

Potassium, like phosphorus, is usually present in sufficient quantities and hence is not needed.

Calcium, or lime, is not a fertilizer but is valuable because of its physical and biological effects on the soil. Lime corrects soil acidity and is thus of benefit in growing leguminous cover crops. It makes available other elements such as potash and also helps to make heavy soils more friable and open. On soils that are heavy and which tend to bake or where it is difficult to grow legumes because of acidity, applications of lime would seem to be warranted. Agricultural limestone is one of the cheapest and most satisfactory forms and generally gives satisfactory results when applied at the rate of one to two tons per acre every three or four years.

THINNING THE FRUIT

It is recognized by many growers that certain varieties of plums at least should be thinned if fruit of good size and quality is to be obtained. With a view to establishing these two points, and also to determine the effect of thinning on annual bearing and the general health of the tree, the Experiment Station at Vineland started certain thinning experiments in 1922. Three seasons results are available at this time, 1922-1924 inclusive, and a considerable amount of interesting data has been secured. The results to date, and the general question of thinning plums, are discussed in the succeeding paragraphs.

Effect of thinning on vigour and hardiness.—1922 was a heavy crop year for plums. Instead of thinning all trees in the Station orchard that year, as had been the usual custom, unthinned trees were left as checks in several varieties as follows: Reine Claude, Gueii, Duane and Lombard. Apart from the effect of thinning on size, quality and maturity of fruit, which will be discussed later in some detail, marked effects on the vigour of unthinned trees as against thinned trees were noted. In the spring of 1923 it was found that all 1922-thinned trees were in a good vigorous condition and they subsequently bloomed and set well. The trees unthinned in 1922, Reine Claude in particular, showed quite marked winter injury. In addition, the unthinned trees generally carried much less bloom than the thinned trees, which were full again. Gueii, unthinned, had practically no bloom. Lombard was very light, Reine Claude and Duane light. Furthermore the unthinned trees were from one to three days later in coming into bloom, an indication of lowered vitality.

In 1923 it was generally observed throughout the Niagara peninsula that trees which bore heavily in 1922 failed to bear in 1923 or bore relatively light crops. Also several cases of quite severe winter injury were noted. One case in particular was an orchard of the Grand Duke variety at Beamsville. This orchard was not in a particularly vigorous condition in 1922, nor as well cared for as it should have been. Nevertheless it bore heavily that year. Much of the fruit, however, was not picked owing to the prevailing low prices. During the following winter practically all the trees were either completely killed out or so badly injured as to render them worthless. The indifferent care of the orchard and the failure to pick the crop were probably contributing causes. Nevertheless the excessive unthinned crop with the consequent drain on the tree must be held mainly responsible, as the orchard had come through other winters in sufficiently good condition.

Effect of thinning on size and quality of fruit.—With all the varieties under observation, the thinned fruit was far superior in size and quality to the unthinned fruit. The accompanying illustration of two baskets of Gueii shows the difference very clearly. Both baskets contained fifteen pounds of fruit, net. The thinned baskets required 200 fruits to make this weight, whereas 373 were required for the unthinned basket. Moreover the thinned fruit went in the highest grade for the variety, while the unthinned were "dumped" as being unfit for shipment.

Apart from the relative value of the two sizes of fruit, it should be remembered that there is practically twice the drain on the tree to mature the 373 fruits, than to mature the 200 inasmuch as it is the number of pits matured rather than the weight of fruit which taxes the resources of the tree. It is not surprising, therefore, that excessive yields of unthinned fruits should so lower the vitality of the tree as to partially or wholly reduce the crop the following year, and with some varieties, as Reine Claude, render them susceptible to winter injury as already pointed out.

The results, as noted for Gueii, were for 1922. The other varieties gave similar results both in 1922 and in 1923 and 1924, though in the latter two years the differences were not so marked, due to the fact that trees unthinned in 1922 bore lightly in 1923 and only moderately in 1924. The effect of thinning on the size of the individual fruits is proportional to the set of fruit. The heavier the natural set the greater the necessity of, and benefit from, thinning.

GUEII. Thinned fruit on left, 200 to fill the basket, fancy grade. Unthinned fruit on right, 373 to fill the basket, inferior grade.

Effect of thinning on yield.—If the above noted increases in size and quality of the individual fruits were accompanied by a corresponding decrease in yield, then thinning would be of considerably less value. Three years' records, however, show the following. The figures given are averages per tree per year for the three-year period, 1922-24.

Table 1. Yields of Thinned and Unthinned Trees

	Thinned lbs. per tree	Unthinned lbs. per tree
Reine Claude	115	92
Gueii	74	90
Duane	195	202
Lombard	106	128

With the exception of Reine Claude, the unthinned trees outyielded the thinned trees to some extent. However, the differences either way are not marked. Of greater importance is the fact that the unthinned fruit of Gueii and Lombard was comparatively worthless.

In addition to this, and of primary importance from a commercial standpoint, there was a marked tendency to biennial bearing in the unthinned trees with the heavy or "on" crop coming naturally in seasons of general heavy production and relatively low prices. This phase of the experiment will have to be carried on for several years yet before definite conclusions can be drawn. It may be mentioned, however, that certain varieties show the biennial tendency more than others. Reine Claude was the least affected apparently. Duane showed a considerable effect, and Gueii and Lombard were noticeably affected, unthinned trees (1922) bearing little or no fruit in the succeeding year, while thinned trees again bore well.

Effect of thinning on time of maturity.—Mention has already been made of the fact that in the year following thinning the thinned trees bloomed earlier than the unthinned trees. The fruit also matured from two to five days earlier on the thinned trees, and moreover it ripened more evenly, all the fruit being in practically the same stage of maturity, whereas the fruit on unthinned trees showed the usual amount of variation to be found on heavily laden trees.

In conclusion it may be stated that the value of plum thinning is probably proportional to the crop carried by the tree. Varieties which naturally load moderately will benefit least. In seasons when the crop generally is moderate to light on all varieties little benefit may be expected. With varieties or in seasons in which heavy sets are experienced, then proper thinning may be considered as a necessary and advantageous practice, its value being indicated in the preceding paragraphs.

PICKING AND PACKING

Is there anything to be said about the picking of plums? Very little, perhaps, except to repeat the oft-quoted rules with regard to other fruits.

Because of the lack of confidence in the plum trade, and prices generally, the fruit is often picked roughly—"shelled," so to speak, in baskets without any particular care being exercised. This applies more particularly to such varieties as Burbank and Lombard. Baskets containing plums of various sizes in different degrees of maturity, sometimes also some leaves, can be purchased on the large markets during the rush of the season. To some extent at least this is the cause of low prices. The grower has had a large quantity and received a medium price which has paid him well enough, but it has hurt the sale of plums as a whole.

A single decayed plum in a basket soon plays havoc with the fruit nearest it, and the infection soon spreads. Much care should be exercised to prevent such waste. The writer has seen baskets of plums—and other fruits also—spoiling on the hands of the retailer. This may seem to be far from the producer, but when the loss from decay is heavy the good fruit must be sold at a correspondingly high price to protect the retailer from financial loss. This is one of the reasons of high cost to the consumer that the producer does not always consider. A large share of the apparently large retail price is due to loss caused by careless picking and packing methods.

At no time should plums be placed in baskets when they are at all damp. This only hastens the decay. All plums are not ripe when they begin to turn blue; German Prunes, for instance, are not ripe till many days later and should be left till in a better state for shipment. They are better picked a little green than overripe though, especially for long-distance shipment. Most of the early Japanese varieties should be picked a little green as they quickly "go down" if overripe. The above are the conditions generally. A few men are more careful, and are paving the way. Their plums are graded into "extra fancy," "fancy,"

"medium," and "Lombard" grades, and as such their fruit is known to the trade. Their baskets of plums carry the same guarantee as their baskets of other fruits and the returns are commensurate with the extra trouble and expense of picking and packing. Wet or damp weather conditions during the ripening and picking season are in some measure responsible for heavy loss from decay in transit and when in the hands of the retailer. Loss at this time cannot be avoided except by careful pruning to admit an abundance of air and sunlight into the tree and by the use of fungicides to prevent scab development.

To the western markets only the best varieties and the best grades should be sent, and the fruit must be picked a little greener than for the nearby markets. As soon as the fruit is partly coloured and has attained nearly full size it should be picked and shipped at once. The week or more in transit will give them some time to reach maturity. For fancy shipments the fruit should be picked with the stems on, the same as cherries are always picked for shipment.

The packing generally consists in putting the plums into the eight or eleven-quart baskets and tacking on the cover. No special packing methods are followed. A few attempts have been made to market in small baskets, four in a case (the western plumcase), but at present the market does not seem to be ready for Ontario fruit in this case. It might be developed in the same steady, progressive manner the box trade in apples has been developed. Eleven-quart baskets are used almost entirely, but the demand for the smaller basket seems to be increasing. At any rate the fruit carries better in them—the smaller quantity—and it is a much more convenient quantity for the consumer to handle. A very large quantity of the product in New York State is marketed in seven-pound baskets and they seem to give satisfaction.

RECOMMENDED VARIETIES

The following list was prepared in 1923 by a committee of fruit growers and nurserymen as the result of a well-defined movement to materially reduce the number of varieties being grown commercially in the Niagara Peninsula. In addition to this recommended list, several other varieties are noted, mainly to point out their defects, thus indicating the reason for not including them in the planting list. The recommended varieties, arranged alphabetically, are as follows:

Arch Duke.—This variety closely resembles the familiar Grand Duke in general appearance. Hedrick, in "Plums of New York," describes the variety as follows: "Arch Duke ought to become one of the leading plums for the market in New York. The qualities, which fit it for a high place among commercial varieties, are large size, handsome colour—a rich, dark purple with thick bloom—and firmness of flesh and skin so that it both keeps and ships well. Arch Duke compared with Grand Duke is nearly as large, neck thicker, the same colour, bloom heavier, quality higher, flesh firmer, stone free, and ripens earlier. The tree characters, like the fruit characters, are good." On the Experiment Station grounds at Vineland the variety yields well and in all ways is considered a desirable commercial variety.

Bradshaw.—This variety also goes by the name of Niagara, and is the earliest good blue plum commercially grown, ripening about the third week in August. It is the heaviest planted plum in many sections. The tree is vigorous and upright, medium to heavy regular bearer, but sometimes comes into bearing late. It is also rather a slow grower. The fruit is a favourite with the consuming public, and also with the canners, as it comes in at a season that is comparatively slack. In quality it is fair to good, colour reddish purple, attractive, large. Bradshaw must be marketed quickly as it does not stand long shipment as well as some other varieties.

Damsons.—There are a large number of varieties of Damson plums, but the one that is of most interest to us is the Shropshire. Damsons have been grown since before Christ, but the variety mentioned above originated in England in the seventeenth century. The trees are vigorous, adapted to a wide range of territory and very productive. The small blue fruit is a little tedious to pick, but it grows in such abundance and such clusters that the trees produce large quantities. It is much favoured as a preserving plum and as such is, at the present time, in much demand on the western markets. The flavour is tart but pleasant, and is well worthy of more consideration than it has received of late. Damsons are well known to the trade everywhere and are in demand. Season of ripening is late.

Field.—Concerning this variety, Hedrick, in "Plums of New York," writes as follows: "This offspring of Bradshaw resembles its parent in tree, and in size, colour and shape of fruit. . . . The Field is a trifle smaller, the fruit is more nearly round, lacking the prolonged neck of Bradshaw and is more plump at the base, the parent plum being markedly obovate. Field is earlier than Bradshaw, the latter difference accounting for the synonym, 'Early Bradshaw.' The quality is not such as to commend either of these plums, but of the two Field is slightly the better. In tree character Bradshaw excels in having a larger tree and in being more productive." The tree comes into bearing early but is inclined to biennial bearing. It withstands brown rot well, excelling Bradshaw in this particular. The place of Field is to give an earlier plum of the Bradshaw type and for this purpose it has been placed on the list of recommended varieties.

German Prune.—This is in many respects the most popular plum on the market to-day. It is well know to the trade and in great demand. Its size, blue colour, free stone, and excellent culinary qualities, as well as its good keeping qualities, put it in the foremost rank. The trees are vigorous, hardy, fairly regular bearers, but are slow coming into bearing. The fruit changes colour before it is really ripe and because of this it is sometimes put on the market before it is ready. Season of ripening is late September and early October. The German Prune comes almost true from seed and in the past has been propagated in that way. Undoubtedly this accounts for the many variations within the general variety type which have been propagated and distributed.

Grand Duke.—This variety is probably the favourite late-season variety. Its large size, blue colour, firm flesh and handsome appearance generally commend it to the consuming public. The typical "prune" shape also attracts. In quality it is second rate only for dessert purposes, but excellent for all culinary purposes. The tree is hardy, but somewhat lacking in vigour, seldom attaining really large size. They are slow in coming into bearing but eventually bear regularly and well. The variety is highly recommended for commercial planting as a late-season variety. Arch Duke, previously described and of similar type, precedes Grand Duke in season and this gives a longer season for this very desirable type of plum.

Imperial Gage.—The Imperial does well in the Niagara District, especially on the lighter soils, to which it seems better adapted. On very heavy soils the fruit is likely to be lacking in size and quality. The variety is apparently self-sterile which will account for poor yields sometimes reported. On suitable soils and well grown, Imperial Gage is a fine plum, excellent in quality for all purposes, and, next to Reine Claude, the most useful Gage we have.

Italian Prune or Fellenberg.—Has been largely planted in the last few years. It is the leading variety for prune making in the Northwestern States, but in

Ontario has not been tried out in large orchards. The fruit ripens in mid-September, is large, blue in colour and an excellent cooker. When fully ripe it is first-class for dessert. In unfavourable seasons, when maturity is delayed overlong, it is of indifferent quality, being altogether too tart for dessert purposes though excellent as a cooking plum even then. The tree is only medium in hardiness and thriftiness and does not seem to be so well adapted to the varied soil and climatic conditions as some other domesticas. It does not always bear as heavily as might be expected. Given good soil conditions, and when well cared for, it is a good variety in the commercial districts of Ontario. The fruit is in big demand on the leading markets.

Italian Prune

Monarch.—This is one of the most popular market varieties at the present time. The fruit is large, blue, medium to good quality for both cooking and dessert; it ships well and will keep for some time in the basket without waste if picked before too ripe. The tree is hardy, vigorous and an early and abundant bearer. Though it is a comparatively new variety it is largely planted and well known to the trade. It ripens in late September. It is highly recommended for planting in the commercial orchard.

Peters.—This variety was included in the recommended list mainly to give a yellow plum to fill in the season between Imperial Gage and Reine Claude. Peters is of excellent quality, but lacks in size and colour. The trees are large, vigorous and healthy, probably being superior in these respects to any others of the Gage group.

Reine Claude.—This variety of late years has been planted quite heavily because of the demand for canning purposes. It also sells well in the open market. Its yellow colour when ripe and high quality will always give it a place in the plum kingdom. It is considered by many the standard of quality in plums. The tree, however, is tender and not as thrifty as most domesticas, but it bears regularly and well. The tree is subject to winter injury and its short life is probably largely due to this weakness, especially if allowed to overbear. The nursery tree is small compared to other varieties and is more difficult to grow. However, with all its faults it is well worthy of a place in the commercial orchard and will likely continue to be one of the most profitable varieties for some time to come.

Washington.—This is a large fruited plum of the Reine Claude or Gage type, of good quality and attractive in appearance. The flesh is sufficiently firm to ship well, though the variety is subject to brown rot, and needs to be handled carefully and quickly. When marketed in good condition it commands a relatively high price. The trees are large, vigorous, healthy and hardy, and eventually bear regularly and well, though slow in coming into full bearing. The earlier crops are likely to be small.

OTHER VARIETIES

To some, the foregoing list of recommended varieties may seem more notable for its omissions than for its inclusions. The Japanese and Americana varieties are not mentioned, nor several other well-known varieties such as Lombard, Yellow Egg, Golden Drop, Glass, Pond, etc.

The Americana and Nigra varieties are recommended only for those parts of the Province where the more desirable domesticas cannot be grown. Good varieties of this type are Cheney, De Soto, Hawkeye, Stoddard and Wolf. These are all adapted to eastern and northern conditions and, in those sections, have a well-deserved place and reputation.

The Japanese group, including Shiro, were not included in the recommended list for two main reasons. First, it was thought that present plantings were sufficient, even if not already overplanted. Second, their use for culinary purposes, to which they are totally unsuited, and the picking of the fruit immature, which fruit is often marketed as "Green Gages," tended to destroy the market for the later maturing, better quality domesticas. If it were not for this latter fully justified criticism, there certainly would not be the strong objection to the Japanese varieties that there is. Well grown, they are generally handsome in appearance—Shiro being particularly so—of excellent size, and quite pleasing for dessert purposes, eaten out of hand, if allowed to mature properly before picking. On the other hand, a "green" Abundance or Burbank, picked immature to get the early market and to be sold often as a Gage, is an abomination. Consumers cannot be blamed for curtailing their consumption of plums under such conditions. Perhaps then it may be said that the Japanese varieties have a place as well-grown mature fruits for fresh purposes, not as "early Gages." In other words, they are more sinned against than sinning.

More detailed mention of some of the more outstanding Japanese varieties may here be made.

Abundance.—This is perhaps the best known of the Triflora or Japanese group. It is in the lead chiefly because the trees are larger, better formed, and bear larger crops than the Burbank. It is adapted to a wide range of soils and conditions. Abundance, as the name implies, bears regularly and heavily, but the fruit is soft, rots easily and is a poor shipper. It ripens early, a week or so in advance of Burbank. It should be picked before it is quite ripe as it is then less subject to rot, and probably develops a better flavour. Too much license should not be taken with the recommendation to pick early.

Burbank.—Burbank is of somewhat better quality than Abundance, which makes up in part for its less-desirable tree characters. It is of a low-spreading habit, flat topped, and branches drooping somewhat, making it difficult to handle as an orchard tree. The wood is brittle, even for a triflora. It blossoms early and in consequence is sometimes injured by late spring frosts. Otherwise it bears regularly and abundantly, often requiring heavy thinning of the fruit to

insure good size and appearance. The fruit begins to colour some days before ripe, and as in the case of Abundance should be picked before fully matured if it is to be marketed.

Red June.—Is one of the heavily planted Japanese varieties that is not gaining in popularity. It has, however, some points in its favour. It is an early and fairly abundant bearer, blossoms quite late for a triflora and the fruit ripens very early, the last of July or first of August. As such it should have some value when well grown. It must be cross-pollinated to produce well.

Shiro.—This is a comparatively new variety that has become somewhat of a favourite chiefly on account of the handsome appearance of the fruit. It ripens early, and when well grown, is large and of a beautiful yellow colour, with flesh so clear that it is semi-transparent. "The flavour lacks character and is almost insipid, but the flesh is tender, melting and juicy. . . . Despite the flavour, the plum is pleasant to eat and may be ranked as good in quality" (Hedrick). Shiro bears early and heavily, and must be thinned for good results. It is susceptible to brown rot and is therefore another of the Triflora group requiring early picking—a distinct fault because of the bad habits into which some fruit growers may eventually be led.

Wickson.—Is one of the largest plums grown, and because of this and much advertising it was quite heavily planted. It has, however, not proven a success commercially and is deserving only of a place in the garden. The tree is tender and it blossoms too early to always escape frost. It is largely grown in California where conditions are more adapted to its requirements.

In domestica varieties not included in the recommended list the following are deserving of some mention, chiefly on account of their weaknesses.

Curlew.—This variety is not planted commercially, and probably not at all in the Niagara district. In the Experiment Station orchard at Vineland, however, it has shown up quite well in comparison with standard commercial varieties. The tree is moderately vigorous, and the tree characters generally are desirable. It is an annual bearer and very productive. The fruit is medium large, blue, firm, of good quality, very free from rot. Ripens with Washington or somewhat in advance of Arch Duke. Curlew is worthy of a more general trial.

Duane.—The variety is of good size, purple in colour and generally attractive in appearance. The flesh is firm and of excellent colour. Unfortunately, however, its quality is not in keeping with its appearance. "The flesh is dry, tough, sour and clings to the stone, making a plum unfit for dessert though it does very well for culinary purposes. The fruit ripens slowly and colours a week or more before ripe; it is at its best only when fully mature." (Hedrick.) Subject to rot.

Emerald.—This is a plum of the Gage type, being a seedling of Reine Claude. It is quite highly regarded by some growers and should possibly be given greater recognition. It is hardy and productive and very early in season, this being its strong point.

Glass.—This is a large blue plum of medium quality, fair dessert and a good cooker. The tree characters are good, it being very vigorous, hardy and productive, and the variety is, therefore, to be recommended (because of hardiness primarily) for those sections of Ontario just beyond the good commercial districts. Hedrick, in Plums of New York, states that Glass has never attained commercial importance in New York probably because its place is taken by Quackenboss, which it very closely resembles. Latchford, formerly listed by a Canadian nursery, seems to be almost identical with Glass also.

Golden Drop (Coe's).—This variety is of doubtful value commercially. While the tree itself seems sufficiently hardy, it is not robust and is sometimes classed as unproductive though the variety has borne quite well in the Station orchard at Vineland. The fruit is late in maturing, sometimes failing to ripen properly. The variety is perhaps more adapted to its English home and to the American Pacific Coast than to Ontario, from a commercial standpoint.

Gueii.—Holds a doubtful place. It is considered by many to be one of the best varieties because of its hardiness, early bearing and heavy bearing qualities. As such it is undoubtedly a money maker. The tree is vigorous and thrifty. The fruit is medium size, poor quality and not particularly attractive in appearance. The fruit is, however, firm, and it is a fair shipper. Many growers condemn it because it is subject to brown rot.

Hand.—Were it not for unproductiveness, often extreme, Hand, or General Hand as it is often called, would be a very desirable plum of the Gage type. It is the largest and handsomest of this group, of good quality, and the trees, perhaps partly because of unproductiveness, are all that could be desired in size, vigour and hardiness. Lack of productiveness, however, does not permit of a recommendation for commercial purposes.

Lombard.—Lombard has many strong points, notably excellent tree characters, vigour, hardiness and productiveness. For culinary purposes, including commercial canning, it is good. As a fresh fruit, however, it lacks quality. Also the variety often requires thinning if the fruit is to attain its proper size and attractiveness of appearance. Because of lack of quality, and often inferior size also, Lombard usually is a low-priced plum on the market. Regularity of bearing and productiveness make up for this to some extent at least. Some growers claim that Lombard has made them more money than any other variety. At the same time there are often years when large quantities are not picked. The money is made from large quantities quickly handled at low prices. It is largely planted all over Ontario and well known to all, but in the light of present prices and developments, except where the grower is prepared to spray thoroughly for rot, and then when needed thin the fruit, it is not to be recommended for planting.

Pond.—Well grown, Pond is a large and handsome plum of a peculiar reddish colour. The fruit lacks quality, however, and the trees are not sufficiently productive and generally seem to lack somewhat in vigour and robustness. Austrian Prune plum, so called by the U.S. nursery firm introducing the variety, is apparently identical with Pond as grown on the Station grounds.

Quackenboss.—This variety has been a favourite with many growers because of its large size, handsome blue colour and good shipping qualities. The tree is large, hardy and vigorous and usually bears well, though in the Station orchard it is not as productive as Glass, and Glass is probably to be preferred therefore. It equals Quackenboss in other respects, and is of the same type and season. Neither Glass or Quackenboss were included in the recommended list as their season is practically the same as Arch Duke, a more desirable variety for commercial districts.

Shipper's Pride.—This variety is grown in small numbers in all the plum districts, but has never come into prominence, because it is only a medium bearer and is susceptible to rot. It is a medium size blue plum of fair quality, good for canning and a good shipper. "The variety has too many faults to succeed in competition with the many good plums of its colour and season." (Hedrick.)

Smith Orleans.—Has been planted quite largely but is losing ground. It is a medium to large sized blue plum but ripens in late August at a time when plums are plentiful. Scarcely worthy of a place in the commercial orchard with such a large list to choose from.

Yellow Egg.—This variety is widely distributed and well-known but is losing favour because of its extreme susceptibility to rot. The fruit may appear to be free from rot when picked and shipped, but they go down rapidly after shipment. Its large size and yellow colour make it attractive to the purchasing consumer, but its quality is only fair. It has not won a leading place in years of test in Ontario.

A good type of Monarch top worked on Lombard.

TOPWORKING THE PLUM

It is generally conceded that there are altogether too many varieties of plums of poor quality growing in Ontario, and that these poor varieties contribute to the difficulties of marketing. Many of these inferior varieties are strong growing trees and would probably make good stocks on which to graft other better varieties. Plums as a class can usually be topgrafted with a fair degree of success provided the trees are sound and not too old or large.

Various methods of topworking may be used, but the best results seem to be obtained by cleft grafting and whip grafting. Cleft grafting is recommended for branches of one-half inch up to two inches in diameter, and whip grafting

for branches of one-quarter to one-half inch in diameter. Budding on fresh young shoots growing on the lower part of the foundation branches is also a good method. For details of grafting and budding see Ontario Department of Agriculture Bulletin No. 294.

INSECT PESTS AND DISEASES

Among the more destructive insects affecting plums, are Plum Curculio, Red Spider and San Jose scale. These and others of lesser importance are dealt with fully in Bulletin No. 250 of the Ontario Department of Agriculture, which bulletin may be had on application to the Department at Toronto.

The chief diseases of the plum are black knot, brown rot, leaf spot and plum pockets. These diseases, together with their control are fully dealt with in Bulletin No. 257 of the Ontario Department of Agriculture.

Generally, the above insects and diseases are controlled by the regular sprays as outlined in The Spray Calendar. These sprays are as follows:—(1) Bordeaux or lime-sulphur, winter strength as the buds are bursting. (2) As soon as shucks are off the small fruits spray again with lime-sulphur one to forty, with extra hydrated lime added. (3) Same spray as (2), two weeks later. (4) Spray those varieties subject to brown rot with lime sulphur one to fifty about ten days before the fruit ripens.

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BULLETIN 316] [MARCH, 1926

Ontario Department of Agriculture

HORTICULTURAL EXPERIMENTAL STATION
VINELAND STATION, ONT.

The Cherry in Ontario

The cherry is widely grown in the temperate regions of the Northern and Southern Hemispheres. It is also one of the oldest known fruits and is said to gave been cultivated by the ancient lake dwellers of Switzerland and the prehistoric inhabitants of North America.

A nicely headed sour cherry orchard. Trees that are high up in the air increase the cost of picking, pruning, etc.

The cherry belongs to the Genus Prunus, a plant division which includes peaches, almonds, plums and apricots. There are more than one hundred species of cherries and approximately 1,100 varieties. Of these species very few

are of value for their fruit, and of the numerous fruiting varieties only a limited number are suitable for Ontario.

Cultivated cherries are roughly classed as sweets and sours, and these again may be further classified by the colour of their fruit.

Relative Importance of Sweets and Sours.

The development of the cherry industry in this Province, both in sweet and sour varieties, is of very recent origin. During the period 1900-15 particularly the growing of sour cherries made wonderful strides. A few years ago in sections outside of Niagara one could find only a few of these cherry trees in the home garden, or perhaps a few of the common red cherry scattered along some old fence row where they had been planted by nature. In the report of the Ontario Fruit Growers' Association for 1883 there appears a discussion on the subject, "Can Cherries be Profitably Grown in Ontario?" Mr. D. W. Beadle of St. Catharines, for many years secretary of the Association, in discussing the above question said, "I do not believe that the planting of cherry trees, with a view of raising fruit for market, is likely to be a profitable business in this neighborhood—not at present at all events. At present I would hesitate to advise men to plant cherry trees with a view to profit." The above remarks seemed to fairly well voice the sentiments, as brought out in the discussion, of the entire meeting. In the 1891 report of the Association, Mr. G. Fisher, of Burlington, stated that "Cherries are being put out but as yet no large plantations are fruiting." The development of the cherry industry then, has been one of practically only twenty-five or thirty years—and now the talk is of over-production. At the present day there are many commercial orchards in Ontario scattered over that part of the Province west of Toronto to the Georgian Bay, along the Lake Ontario shore east of Toronto, and of course in the Niagara District.

The sour cherry is one of the most regular bearing tree fruits, a heavy cropper and an early bearer. It will do well on almost any kind of soil, providing it is well drained, except heavy damp clays or low-lying land. Our hardiest cherries are sour varieties and they have, therefore, been planted over a much wider range than the sweet varieties. The probable northern limit of sour cherry culture is latitude 46 degrees. North of that the fruit buds are very likely to be killed by the cold winters, though the tree itself may be perfectly hardy, so that it is only rarely that a crop is produced.

The sour cherry is planted frequently as a filler in the apple orchard until the apple trees require all of the ground. It fills the prime requisites of a filler excellently, being comparatively small growing, and, as previously stated, an early regular bearer. The main objection to its use as a filler is that its spray programme is different to that of the apple. In spraying for the cherry fruit fly, for example, the apples as well as the cherries would have to be sprayed.

With the sweet cherry conditions are somewhat different. It is greatly limited in its successful culture by soil, location and climate. In general it might be said that the sweet cherry succeeds commercially only where the peach may be successfully grown. In the whole of the Niagara District there are very few real commercial sweet cherry orchards, most of the trees being not in orchards, but in some favoured location near the house or along the road. From a survey of the Niagara District made in 1910, it appears that there were only about 7,200 sweet cherry trees, or about one-tenth as many as there were sours at that time. In the townships of Niagara, Grantham, Louth and Clinton there were only 2,726 bearing and 846 non-bearing sweets.

Propagation.

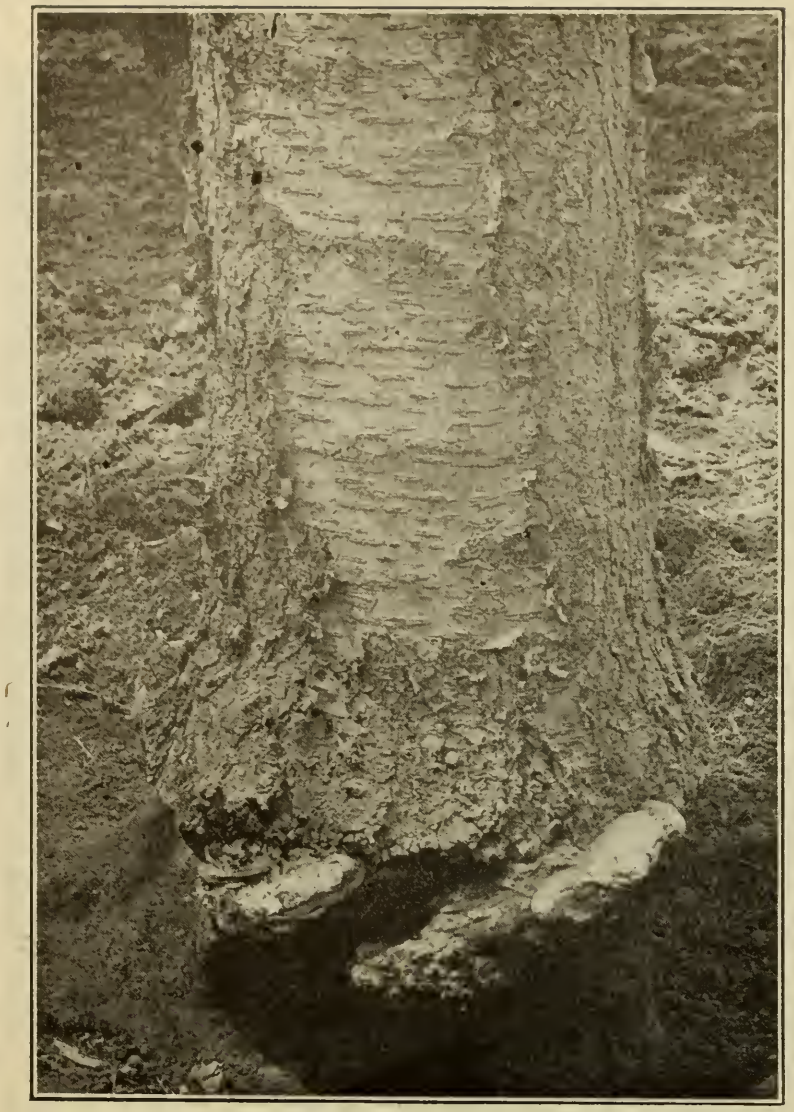
The great majority of the cherry trees in this country are propagated by budding on the Mazzard (*Prunus Avium*), a sweet cherry stock, and the Mahaleb (*Prunus Mahaleb*), a sour cherry stock, usually regarded as hardier than the Mazzard. Morello (*Prunus Cerasus*) and Bird cherry (*Prunus Pennsylvanica*) stocks are very hardy, and will no doubt prove valuable where extreme hardiness is required. The latter stock has been used at the Central. Experimental Farm, Ottawa, with good results.

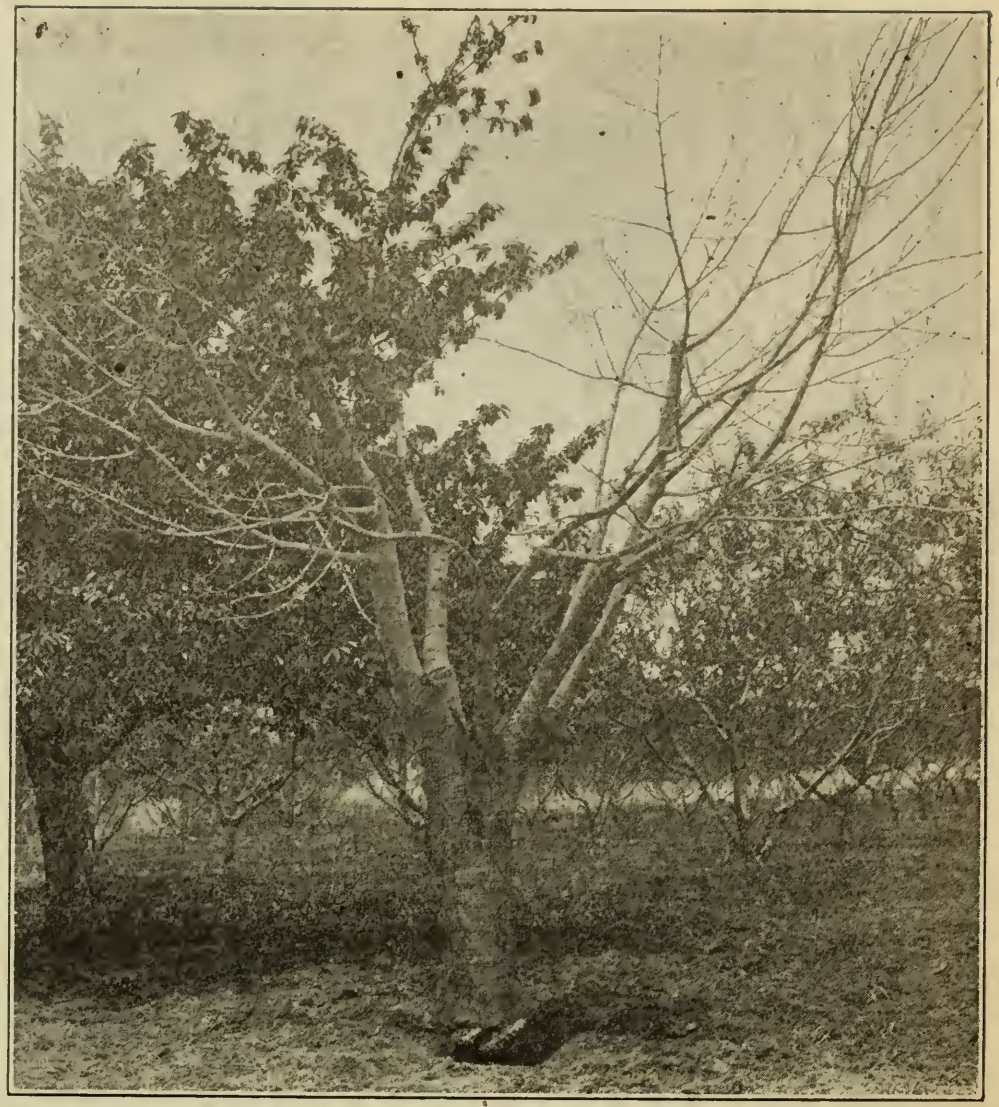
Seedling stocks are imported from France in the winter, planted the following spring, and budded in the summer of the same year if of sufficient size; otherwise they are allowed to grow for a year. Cherry stocks may be worked by either budding or grafting, budding, however, being the method followed commercially. The budded stock is usually taken out of the nursery row in the fall and either heeled in outside in a well-drained location or piled in bundles in storage houses where the temperature is kept sufficiently low to prevent any starting of the buds. During the winter the stock is graded and packed for spring delivery. Trees are usually sold as two-year olds.

Regarding the two chief stocks, Mazzard and Mahaleb, the former is probably the best stock. Upon it varieties of either sweet or sour cherries make larger, thriftier, longer-lived and more productive trees. From the nurseryman's point of view, however, the Mahaleb is the best stock to use. It is cheaper, possibly hardier, more easily budded, the buds develop more quickly into saleable trees, and, as it stands in the nursery row, the stock is more immune from insect and disease attacks. The Mahaleb stock also seems to be better adapted to planting in heavy clay soils. But where the Mazzard is sufficiently hardy it is the best stock for the fruit grower. As regards hardiness of stock, this point seems to have been given more prominence in the past than it deserves. The northern limit of successful cherry culture is determined not so much by hardiness of stock as by hardiness of fruit buds. The tree will thrive but bear no fruit because of frost injury to the buds.

Location and Soil.

With sour cherries location is possibly of secondary importance except that low-lying land should be avoided. With sweet cherries, however, location is all important. The soil can be changed to a certain extent but the effect of location cannot, so that it is best to look to location first, and then if the soil is not all that is desired, study and add to its requirements afterwards. Cherries, especially the sweeet varieties, are very likely to be injured by frosts, cold rainy weather, etc., during blossoming time, so that a somewhat exposed situation in close proximity to a large body of water is desirable, as in such a location blossoming is retarded and the danger thus usually averted. The soil for cherries must be well drained, as neither sweet nor sour varieties will thrive with "wet feet," sweet cherries being more susceptible in this respect than any other of our tree fruits. The cherry thrives best on a light soil. Therefore, the ideal location and soil would be a somewhat exposed spot, rolling enough for good air and water drainage, with a deep gravelly subsoil, a sandy loam top-soil, either naturally or artificially drained, and sloping preferably to the northeast, so that blossoming may be delayed as long as possible in the spring. A district that is generally level is very likely to be frosty. Also a very sandy soil should, perhaps, be avoided, as it becomes too hot in summer and the trees are apt to be injured by drouth before they have made enough root growth to protect themselves.





Trunk of Elkhorn grown on Mahaleb root, showing variation in size between the trunk of the graft and the root stock. The tree has been attacked at the junction by a shelf fungus. Sweet cherries on Mahaleb stock are short-lived, as the above photos clearly indicate.

With further regard to the influence of adjacent large bodies of water, it has been observed that orchards so situated and near the northern limits of cherry culture will succeed well and produce good annual crops when other orchards in the same latitude, but away from the influence of the water, suffer severely from injury to the fruit buds, even though the temperature during the winter does not fall any lower than in the former case. This peculiar condition is due to the fact that it is not so much the intensity of cold which kills the blossom buds as quick changes in temperature, short cold spells alternating with warm sunny weather. Locations near water are less susceptible to rapid changes in temperature, which are so hard on the blossom buds.

The sour cherry, as previously intimated, will adapt itself to more adverse conditions than the sweet, and therefore can be planted in less favourable soils and locations provided soil and air drainage are good, and the trees do not blossom too early in spring so as to avoid injury from late spring frosts. It will grow on many soils except a heavy, damp clay, or a low-lying spot, but thrives best on a heavier soil than that recommended for the sweet cherry. A location in which there is standing water for any length of time, either on or a short distance below the surface of the ground, will not grow cherries any more than it will grow apples or peaches. "Wet feet" must be avoided at any cost.

The cherry, then, must have good soil drainage, whether natural or artificial. It must have good air drainage; and a light soil with a northeast slope for sweets in particular is to be preferred and should be secured if at all possible. A south slope should always be avoided for a sweet cherry orchard, as there is greater danger of sun scald, and also early blossoming is stimulated, which is undesirable. In planning to set out a young orchard, too much attention cannot be paid to the above points concerning location and soil. On them largely depends the success or failure of sweet cherry culture.

Planting.

Fall vs. Spring.—The cherry starts to grow very early in the spring. Therefore, if spring planting is to be followed, the trees should be planted as early as the land can be worked, and, of prime importance, while the buds are still dormant. If the trees have started to burst their buds before planting, a large per cent., especially of the sweet varieties, will fail to grow. This brings up the question of fall planting, and so far as the observation of the writer has gone, fall planting is to be recommended over spring planting for districts at any rate where the sweet cherry will succeed. That is, it is to be recommended over spring planting as the latter is generally practised, which is after the buds have started—too late in the season for good results. In the colder cherry sections of the Province, and more particularly those away from the influence of a large body of water, it would be safer to test fall planting in an experimental way only. Much of the difficulty experienced by growers in getting sweet cherries to grow is probably due to the trees being planted too late in the spring. Hence the advantage of fall planting, as the trees are in the ground and ready to start growth with the first signs of spring. It must be borne in mind, however, by those intending to fall plant that the nursery stock must be fully ripened up before bring transplanted from the nursery row to the orchard. If trees in which the wood is not fully ripened up are secured from the nursery, winter killing is almost sure to follow. Other things being equal the percentage of loss from fall planting will be less than from spring planting as *ordinarily practised*, but as previously intimated, poor results are probably due to the planting

being put off until too late. If spring planting were done in time, that is, before any signs of growth appear, it is likely that almost, if not quite, as good results would be obtained as with fall planting.

Preparation of Soil.—With regard to the preparation of the soil before planting, best results will be secured if the land is tilled or cropped for one or two years previous to setting out the orchard. Green crops ploughed under add a large amount of humus to the soil and leave it in the best possible condition. A leguminous crop, such as clover or vetches, is especially good, since it increases the supply of nitrogen in the soil and promotes a strong growth in the newly-planted tree.

The preparation of the soil for planting should commence with fall ploughing, leaving clayey lands as ridged as is consistent with good ploughing. Cultivate the land down early in the spring, and plant the trees as soon as possible, leaving further cultivation until after this is done, as the importance of early planting when spring planting is practised, cannot be over-emphasized.

Distance of Planting.—In common with most of our other tree fruits, cherries, and more particularly the sweet varieties, are usually planted too close together. Low heading is the slogan of the present day fruit grower, but unless heavy cutting back is resorted to, it is impossible to keep a too closely planted orchard low headed. Sunlight and air are required by the tree for its development, and it naturally grows up in the air in direct proportion to the amount of each of these factors cut off by its crowding neighbours. Plenty of sunlight and free air circulation are also required for the development of strong fruit buds. The direct result then of too close planting is that the lower branches become unproductive and finally die away, and the productive part of the tree is much higher up, making the operations of pruning, spraying and picking correspondingly more expensive. With closely planted trees it is also more difficult to cultivate and spray, and consequently brown rot, to which most sweet varieties are quite susceptible, is given the most favourable conditions for its development—a close humid atmosphere with very little air movement. During the season of 1914 the writer was in a sweet orchard cherry in the Niagara District in which practically half of the fruit was ruined by rot. This loss was a direct result of overcrowding of the trees (they being planted 16 ft. x 18 ft.), combined, of course, with unfavourable weather conditions. From this and other observations it would appear that sweet cherries should be planted at least 24 feet apart each way and sour cherries at least 18 feet each way. It would perhaps be better to recommend 25 x 25 or more for sweets and 20 x 20 feet for sours, as even these distances would not be allowing any waste room. Just as much good fruit to the acre will be produced at these distances as if the trees were planted closer, and the fruit will not all be at the tops of the trees. Furthermore, all orchard operations will be facilitated and insect and fungous diseases will be far more easily controlled.

Laying Out the Plantation.—Several methods may be used to lay out the orchard, any one of which will give good results if carefully done. Probably one of the simplest and best methods is by the use of a marked wire. Exactly parallel lines of stakes at a distance apart decided on for the trees, are first set, one line on either side of the field. The wire marked at the proper distances, say 20 or 25 feet, is then stretched across the field from stake to stake, care being taken that the end marks and end stakes coincide. The wire should be attached to stout stakes which are then driven into the ground to hold the wire taut. Light stakes are then driven in at each mark on the wire and the wire then

moved for the next row, etc. In using this method it is obvious that the wire must be stretched tightly each time and the end wire marks must coincide with the base stakes.

Planting.—In planting the chief point to remember is that the tree must be set firmly in the soil. Occasionally one sees young orchards of cherries and other of our tree fruits also, in which tree after tree had died from, according to the owner, some unknown cause. The cause, however, is usually easily found. A slight pull will bring up many of the trees, especially the dead ones, and it becomes evident at once that their death was due simply to the fact that they had not been sufficiently "firmed" at planting time. This firming of the soil is of particular importance with light soils such as the cherry thrives best in,

An orchard that might better have been headed considerably lower and a saving thus effected in picking, pruning and spraying.

and great care should, therefore, be taken to see that each tree is firmly planted. In very light soils it may even be advisable to use a ram to firm the soil, as in such soils foot pressure is hardly enough. The firming simply insures that the soil is packed tightly around the roots, giving the roots every opportunity to draw moisture and food from it. A loose soil also dries out very rapidly, making it still more difficult for young trees in such soil to make a start.

In planting the tree make the hole large enough to receive the roots without having to force them in, place a shovelful of dark top-soil in the bottom, set the tree in, throw in a few shovels of earth, shake the tree up and down a little to get the soil close to the roots all around them, firm the soil well with the feet, and

finish filling in the soil, firming it constantly, but finally leaving a mulch of loose earth on top. In addition it would possibly be an economic operation with newly-planted sweet cherries to water them two or three times during their first summer.

In fall planting the tree should be set a little deeper than is usual for spring planting, and the earth mounded up for two or three inches around the trunk. Pruning should be left until the spring as then any immature wood that is killed back during the winter can be readily seen and removed.

If one-year-old stock can be secured from the nursery so much the better as the tree will transplant easier and thus have a better chance of living. Apart from this consideration two-year-old stock is ordinarily preferred to the one-year. It usually requires very little shaping when received from the nursery, the one-year stock holding little or no advantage in this respect.

Pollination.

Sour cherries are usually self-fertile and consequently may be planted in solid blocks of one variety without adversely affecting the yield of fruit. Sweet cherries on the other hand are self-sterile and hence will not yield well if planted in solid blocks of one variety or singly at some distance from other varieties known to be good pollinators. Certain varieties, notably Bing, Lambert and Napoleon are also intersterile and consequently will not bear well when planted together unless good pollinators are growing nearby. The self-sterility and intersterility of sweet cherries makes it necessary to intermingle varieties in planting and to pay special attention to the choice of varieties known to be good pollinators. Investigational work done in Oregon and California shows that Black Tartarian and Black Republican are good pollinators for most other varieties of sweet cherries. There is also some evidence to show that the Duke varieties are useful for this purpose. The commercial value of the pollinator varieties should be given some consideration in choosing pollinators. For example, Black Tartarian is a good commercial variety and should be used in preference to Black Republican, a variety that is not highly esteemed in Ontario.

The number of pollinators to use in proportion to other good varieties varies somewhat. Some authorities recommend planting one pollinator to five of the other varieties, while others believe that one in nine is enough. Where this proportion is used it is suggested that every third tree in every third row be a pollinator.

Cultivation, Fertilization, Etc.

Cultivation is one of the most important factors of success in commercial cherry growing. That is the generally accepted rule at the present time though only a comparatively few years ago an extremely opposite view was held. It is very interesting to read back in some of the older Annual Reports of the Ontario Fruit Growers' Association, where we find such statements as these: "Possibly we have no fruit tree that requires so little cultivation and dressing as the cherry. It seems to succeed best on our light soils, where no manure is used." (Report for 1881.) "The ordinary treatment is extremely simple. I will give you the secret. It is to plant the trees along the fence, and let them grow with the burdocks and berry brambles and anything that comes along." (Report for 1883.) "As Mr. Gott suggests, we find that the cherry does better to be neglected a little, rather than to be cultivated, and fed and tended carefully. Those who grow the largest crops grow them on the outlying ground,

where they receive very little attention." (Report for 1883.) Several years later the 1891 report of the Association showed that one or two of the more progressive cherry growers were coming to the conclusion that cherries could stand cultivation as well as our other fruits. The following statement by the late Linus Woolverton appears in the report for the above year 1891: "I was told that cherries should not be cultivated, and formerly I did not cultivate them. Of late I have cultivated a small cherry orchard, and the results were so much better that I cannot see the wisdom of the advice formerly given." At the time of writing, 1926, it is interesting to note that there is a tendency here and there to swing back to sod culture for sweet cherries.

In the short space of thirty years the cherry industry has progressed from a state of almost total lack of cultivation to one wherein thorough cultivation is regarded as probably the most important factor. Cultivation is in one way a fertilizer itself for, apart from its great value as a conserver of soil moisture, it renders available food that the tree otherwise would not be able to use. Cultivation lets air and sunlight into the soil. Chemical actions of various kinds are thereby induced, liberating in turn plant food for the use of the tree.

Either clean cultivation with the use of green manuring or cover crops, or intercropping the young orchard with small fruits, are excellent plans, provided of course that good orchard practice is followed in each case. In the so-called cover crop method (this term being used to designate green manuring also) the orchard should be ploughed as early as possible in the spring (the cherry is an early crop and hence should be one of the first parts of the orchard to receive attention in the spring), and cultivated thoroughly until about the time picking commences. Then, after picking is over, cultivate once or twice more and sow the cover crop which is to be ploughed under the following spring. Care should be taken to stop cultivation soon enough to give the wood ample time to ripen up before winter, and so avoid danger from winter injury. Leguminous plants, such as red clover and hairy vetch, are excellent for use as cover crops, while rye, buckwheat, etc., are also good, though they do not add nitrogen to the soil as do the former. The many uses and advantages of cover crops as a regular practice in the orchard have been so freely discussed in various bulletins, farm papers, etc., that it seems hardly necessary to say anything further here. Only the time of sowing, late July or early August, depending mainly on the factor of soil moisture at the time, need be mentioned. One other point might be added; that a great deal of the value of a cover crop lies in the thoroughness of the accompanying soil cultivation during the early part of the summer.

The question is often asked: "When should I stop cultivating my cherry orchard in the summer?" Theoretically, cultivation should be continued as long as possible, but ceasing early enough to allow the wood to ripen up well before winter, which would be about the middle or end of July in the Niagara District and earlier in the colder sections. Practically, however, cultivation usually stops when the early varieties start to ripen and picking commences, as time is valuable from then on for one thing, and also the limbs of the trees are so weighted down with fruit that cultivation is difficult. Young non-bearing orchards, of course, could and should be cultivated as long as possible—say to the end of July or even later—so as to promote a strong and vigorous growth. It would be well too, if bearing orchards were cultivated some after harvesting is over, instead of ceasing cultivation with the ripening of the Early Richmond.

If the system of intercropping the young orchard be followed, one or two things must be remembered. These small fruits take a great deal of plant food

from the soil, and care must, therefore, be taken that the soil is kept replenished with the necessary plant food, else the cherry trees will not make a healthy and thrifty growth. Also the trees must be given more room as the orchard becomes older, which means that less and less room should be given over to the intercrop, and finally when the orchard is about six years planted, the intercropping should be discontinued. The usual mistake is that the intercropping is continued until it has injured the orchard trees by taking much of their food, and crowding them so that they do not obtain a free circulation of air or sufficient sunlight. In this connection it would seem advisable not to plant bush fruits in a young sour cherry orchard, as the branches of sour varieties start to spread early. Therefore, plant strawberries or a root crop in the sour cherry orchard. With the sweets, which are high growing, there is no objection to intercropping with bush fruits.

A young cherry orchard interplanted with small fruits. This intercropping should be discontinued when the orchard is five or six years old and the whole space given over to the trees.

Except in the case of a cover-crop which it is desired to leave until spring, ploughing may be done either in the fall or early spring in the Niagara District. In other commercial sections preference should probably be given to spring ploughing as there is much less danger of winter injury to the roots, though a Prince Edward County grower regularly practises fall ploughing with, so far, no apparent injury. The advantage of fall ploughing is, of course, that it relieves the spring work.

Fertilizers.

The fertilizer recommendations formerly made for fruits have been based largely on the plant food requirements of field crops, particularly cereals. These

recommendations included the use of Nitrogen, Pottassium and Phosphorus as essentials for the best results in growth and yield. Recently completed investigations, however, show that the food requirements of cereals and fruits are quite different and that the old recommendations are not entirely sound.

These studies show that nitrogen is very often the limiting factor in fruit soils. This element makes a vigorous growth of stem and leaf and is an important factor in the formation of fruit buds and in securing a good set of fruit. Nitrogen may be incorporated in the soil by the addition of stable manure, leguminous cover crops or by nitrogen bearing fertilizers. Where stable manure is readily available it should be used not only for the nitrogen which it contains, but also because it furnishes organic matter to the soil. This organic matter decays and forms humus, which is the basis of soil fertility. Without the presence of humus heavy soils will bake and become very hard in dry weather, and light soils will suffer more severely from drouth. The principal food requirements of plants, that is, nitrogen, phosphorus and potassium may be in the soil in abundance but without a good supply of humus, the soil will not be fertile. In other words humus is the conservator of these important plant foods. Cover crops ultimately furnish humus when plowed under and may be used as a substitute for stable manure. When leguminous cover crops are grown nitrogen is restored to the soil through the action of nitrogen fixing bacteria which operate in the nodules on all leguminous plants. These plants are therefore more valuable than non-legumes and should be given the preference in the choice of cover crops.

The nitrogen requirement of cherry orchards could in all probability be met by moderate applications of stable manure and the plowing under of legumes. If this treatment does not produce the desired results in growth or fruitfulness commercial fertilizers such as nitrate of soda or ammonium sulphate should be used as a supplement. The quantity to use will be determined by the size and condition of tree. A general rule followed by some orchardists is to use ¼ lb. per tree for each year of its growth.

Phosphorus, or phosphoric acid as it is usually called, is present in most soils in sufficient quantities for the needs of tree fruits and therefore applications of this fertilizer are not likely to be of value to the trees directly. This element, however, often stimulates the growth of cover crops and hence is of indirect value to the tree in producing growth and fruitfulness. Where the growth of cover crops is not satisfactory applications of phosphatic fertilizers such as acid phosphate, bone meal or phosphate flour would probably be beneficial.

Potassium, like phosphorus, is usually present in sufficient quantities and hence is not needed.

Calcium or lime is not a fertilizer but is valuable because of its physical and biological effects on the soil. Lime corrects soil acidity and is thus of benefit in growing leguminous cover crops. It makes available other elements such as potash and also helps to make heavy soils more friable and open. On soils that tend to bake or where it is difficult to grow legumes because of acidity, applications of lime would seem to be warranted. Agricultural limestone is one of the cheapest and most satisfactory forms and generally gives good results when applied at the rate of 1 to 2 tons per acre every three or four years.

Pruning.

Sour Cherries.—In the past we have been led to believe that cherries should not be pruned at all heavily, but rather that pruning, if practised at all, should

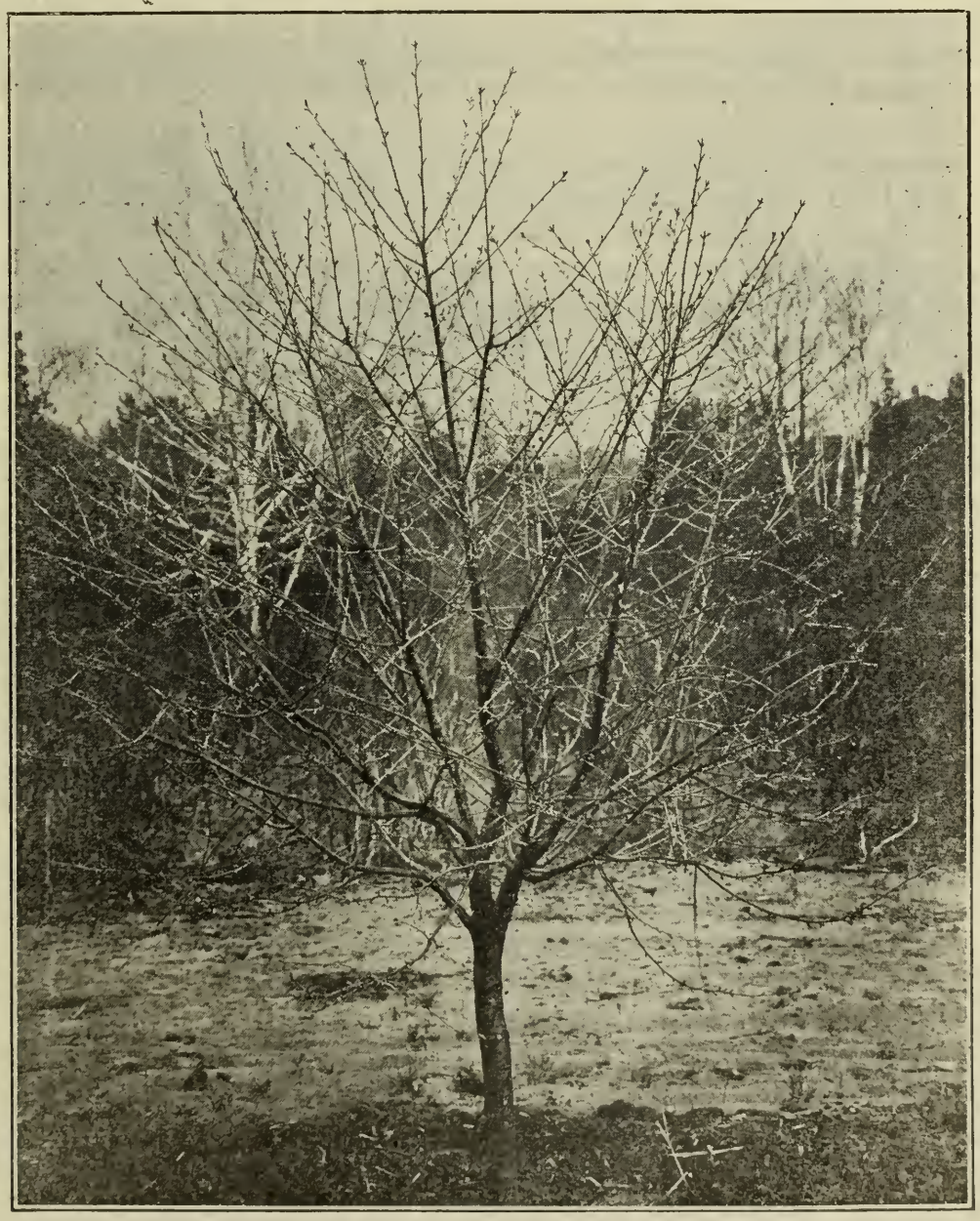
be very light, as otherwise considerable damage would likely be done to the trees. In the light of present knowledge it would appear that the sour cherry, and the sweet too, really thrive with pruning; at any rate they may be given far more pruning than has generally been recommended in the past without harm to the tree or the crop. The illustration below shows one of a dozen or more English Morello trees at blossoming time, which was "renovated" somewhat after the manner quite often adopted for old peach orchards. The main limbs were all cut back before growth in the spring to about one-foot to two-foot stubs without any apparent injury to the trees, for a very vigorous and productive new growth soon resulted. Before being cut back these trees were very straggly in appearance, and, as is often the habit with sour cherries particularly the English Morello, considerable of the fruit was borne in clusters at the tips of long, bare whip-like branches. The dehorning gave rise to branches which

An English Morello tree in blossom at the beginning of the third year after having had all of the main branches cut back to stubs of less than two feet long. The photograph therefore shows two years' new growth.

were productive throughout their entire length, of extra large fruit of excellent quality. The profusion of blossom as shown in the illustration testifies as to the quantity of fruit for the amount of bearing surface on the tree. The photograph was taken the third season after dehorning.

The sour cherry is naturally very symmetrical in growth, and ordinarily requires very little shaping. Intercrossing limbs should be removed and some of the branches thinned out. Heavy cutting back mentioned above is not recom-

mended as a general practice, except in cases where the trees have become unproductive through bearing considerable of the fruit in clusters at the tips of bare branches. With further regard to this habit of the sour cherry it seems reasonable to suppose that if the trees were kept sufficiently thinned out from the start there would be more likelihood of having fruit borne all along the branches. Fruit buds will not develop where there is a lack of sunlight and air circulation, and the sour cherry trees as we ordinarily find them are fairly dense, and certainly much thicker than would be recommended for any other free fruit. It is questionable, however, if fruit spurs could be kept in a productive condition for any great length of time in any case, so that pruning should aim at the annual production of a fair amount of new wood.



A well-shaped young sour cherry tree. Some thinning out of surplus branches should be done, but shortening back of young growth is not necessary.

Sweet Cherries.—The cut on page 15 is that of a sweet cherry tree in the orchard of G. A. Robertson, St. Catharines, and illustrates Mr. Robertson's method of keeping his trees low enough so that he can pick, prune, and spray his orchard with the most economy. The tops and centres of the trees are cut

right out, with no apparent ill effects to the trees whatever, though as with the sour we have been led in the past to suppose that the sweet cherry would not stand such harsh treatment. It might be mentioned here that this method of keeping the centre of the tree open is one of the most effective ways of helping to control the brown rot which does so much damage where conditions are at all favourable to its development. Plenty of sunlight and free air circulation help materially in keeping this disease under control. Part of this pruning Mr. Robertson does in the summer time, part in winter.

The young sweet cherry, until it reaches the age for bearing, requires little or no cutting back, but it must, however, be thinned out moderately. The object is to shape the tree rather than to prune for fruit, it being desired to get a low, well-spread, open-headed tree as quickly as possible. It is essential that plenty of free air circulation be provided for if, as previously intimated, the brown rot is to be successfully controlled; and to this end any unnecessary or intercrossing limbs should be removed as well as the centre of the tree kept open.

In common with what is now generally accepted as the best orchard practice for our tree fruits as regards heading, both sweet and sour cherries should be headed low, say 24 to 30 inches, at planting time. This low heading is of especial importance with sweet varieties, as it helps to protect the trunk of the tree from sun scald. Then there are, of course, the usual benefits from low heading of decreased cost of pruning, spraying, picking, etc. With the modern extension tools, cultivation can easily be given under the lower limbs of the low-headed trees without material inconvenience or chance of injury to the tree. Start the tree low if possible, allowing three to five main branches, and making these strong and sturdy and vigorous by keeping all unnecessary and intercrossing limbs cut out, forming a round-headed tree with plenty of lateral branches.

The above remarks on pruning are only general, and cannot be applied to every variety of cherry. For instance, the Black Tartarian cherry is a very upright grower, and should be kept down by allowing some of the growths from the lower branches to remain and cutting the top of the tree back. The Napoleon has a habit of forming long slender limbs without side branches, and in seasons of a heavy crop, bunches of small inferior fruit often form on the ends of the limbs. Therefore it is advisable to keep the limbs stocky and make them send out side branches by cutting them back.

Other varieties again grow too vigorously if pruned much in the winter, and it may then be advisable to practise summer pruning on them occasionally or often as the case requires, doing the thinning out and cutting back of the top at that time. Each grower should study the habits of growth of the different varieties in his orchard and modify the pruning of each to suit. So-called "winter pruning" should be done preferably just before growth starts in the spring or very shortly after. Summer pruning is best done about picking time.

Once the trees are in bearing they need comparatively little in the way of pruning except to keep all weak and unnecessary limbs cut out, the centre of the tree open to the sun, and the top of the tree within a reasonable distance of the ground. An annual production of new wood should also be maintained.

In discussing pruning and the keeping of the tree open we ordinarily overlook one very important point; the fruit on a well-pruned tree ripens far more evenly than on a tree that is too thick. In such a tree much of the fruit on the inner and shaded branches will still be green and unfit when the rest of the fruit is mature. It is important to have the fruit ripen as evenly as possible as pickers working by piece work naturally object to making two pickings. If

pickers were paid by the day two pickings could, of course, be made. By judicious pruning, however, practically all of the fruit can be made to mature at the one time.

Summarizing the question of pruning, one can do no better than give it in the words used by Mr. G. A. Robertson in a discussion on the above subject: "The pruning of cherry trees is absolutely essential to the production of good fruit. It is used to keep the tree down within bounds where it may be sprayed easily and the harvesting may be done easily and cheaply; by allowing free access of sunlight and air to prevent rot and help colour the fruit evenly so that it may be harvested in one picking. Pruning is used to shape the tree, to cut off old unproductive limbs robbed of their fruit spurs by careless pickers, and to replace them with new growth. It is used in winter to force wood growth in sections where new wood is necessary, and in summer to counteract the effect of heavy manuring and unfruitfulness. The heavy bearing of annual crops after bearing commences checks the wood growth sufficiently to counteract heavy manuring, and in conjunction with July planted cover crops prevents excessive wood growth and ripens the wood, hence annual summer pruning is unnecessary and where not needed would be harmful."

Sweet cherries will stand heavy pruning when necessary. Keep the centres of the trees open, as in the above illustration, to let in plenty of sunlight and allow of a free circulation of air, and keep the tops of the trees low down so as to facilitate pruning, spraying and picking.

Picking, Packing and Packages.

The importance of picking fruit at the proper stage of maturity can hardly be over-estimated. Fruit picked before it is fit for consumption and put on the market early in order to receive for it a probable higher price for such early stuff has a very demoralizing effect on the sale of the main crop of that fruit when it comes on the market later on. The grape season of 1914 furnished an excellent object lesson in this regard—Niagaras were put on the market too green to be fit for consumption. The grocers and consumers got an oversupply and the consequence was that by the middle of the season, when Niagaras should have been moving readily, nobody seemed to want them. In discussing just this situation at the 1914 Convention of the Ontario Fruit Growers' Association, Mr. D. W. Clark, one of the leading retail grocers of Toronto, said; "I do not think it is any benefit to the growers to ship out green grapes. If I got such a case as that, I would shift the fruit grower for the whole season." As Mr. Clark would do, so would other retailers and consumers, and as with grapes, so with all our fruits, cherries included. It should also be remembered by the growers that fruit picked too soon does not give the quantity that would otherwise be obtained by waiting a few days for the fruit to swell out and attain full size. It is likely that the increased quantity would then almost counterbalance the higher price for early stuff, and in addition there would be satisfied customers who would come back for more fruit.

For local markets, cherries should be picked when fit for consumption, not before. For distant markets, such as the middle west, they should not be picked until mature; that is, they should be well colored, of nearly full size, and with well-developed flavour, which would admit of their being picked several days before picking for the local markets. There is, perhaps, no objection to starting the picking for the local market at this time also, but it should not be started before the fruit is fit for consumption. Such a practice, if continued, cannot but have a deleterious effect on the market later on. Cherries can be picked and shipped long distances even after they are fully mature. Shipping over-ripe fruit is, of course, objectionable. Over-mature fruit is practically useless for shipment, as it will not stand handling, and arrives unsaleable.

Just here it might be mentioned that, if a variety ripens unevenly and it is impossible to get an even maturity by pruning, fertilizing, etc., it is not the best practice to gather all of the fruit at one picking, but rather make two, taking off such fruit as is of good size and colour at the first picking and the rest later, when it has become larger and better coloured. By this method the fruit left after the first picking will increase rapidly in size and will make just that much more bulk of fruit. The main idea in making the two pickings, however, is to have an even grade in the basket.

In the actual picking of the fruit, the principal points of importance are: first, care when the fruit is for market in picking it *with the stems on* (possibly of no importance when for the canning factory); and second, care in not pulling the fruit spur off to which the stem is attached. Many fruit spurs are pulled off by the pickers along with the fruit, which reduces the bearing surface for following seasons. In some cherry sections of Canada and the United States it is the practice to guard against this by clipping the stems, of the sour varieties especially, with small scissors. The stem of the sweet varieties parts more readily from the fruit spur, hence it is not so necessary to clip them. The fruit can be picked almost if not quite as rapidly when using scissors, and it certainly presents a neater and more attractive appearance in the basket; besides which, of course, many fruit spurs have been saved for the next season's crop. Also

when the fruit is clipped there is no temptation for the pickers to pull the fruit off without the stems. If there is much fruit in the basket picked without stems the juice which exudes from such cherries will make the whole basket wet, sticky and unattractive, so that on the market it sells for a very low price. A Michigan grower, Mr. Burton Gebhart, harvests all of his cherries by clipping the stems, and claims he gets on an average 75 cents more on a 16-quart crate of cherries with clipped stems than for unclipped. As it takes from two to two and a half quarts more of clipped stem fruit to fill a 16-quart crate than where the whole stem is left on, this leaves a clear profit of 40 cents per crate over the unclipped stems.

A good type of young sweet cherry tree.

A possible objection to clipping the stems is that the cut end is sharp, and, therefore, liable to puncture the skin of another cherry. But at any rate clipping is a practice that is worthy of trial in Ontario. The stem should not be clipped short off, but should have about three-fourths of its length left.

Never pick and ship cherries, sweets especially, when they are at all damp from dew or rain. Such a condition greatly favours the spread of brown rot,

causing considerable loss before the fruit finally reaches the consumer. As soon as the fruit is picked, the full baskets should be placed in the shade somewhere, not left in the sun, until shipped or taken to the packing house for sorting, facing, etc.

If the crop is to be disposed of to the canning factory the fruit should not be picked until ripe, and to this end two pickings should be made if necessary. If much of the fruit is picked before it is matured, the grower will lose in weight of fruit. Also the factories often prefer to have the cherries pulled from the stem in picking, as this saves them the expense of stemming the fruit themselves—and if the fruit is unripe the stem will often pull out the pit in the operation of picking, causing an additional loss to the grower in total weight of fruit.

Supervision of the pickers should be very strict, so that careless, rough picking without stems, and poorly filled baskets can be guarded against. Also the pickers should be made to gather as much of the fruit as possible from the top of the trees with step-ladders rather than by climbing around inside the tree which often results in scraping the bark badly and knocking off many fruit spurs.

Coming to the question of packing and packages, all green, decayed or cull fruit of any kind should be carefully graded out and the fruit faced enough to give the package a neat attractive appearance. Placing the stems down so that they cannot be readily seen from the top of the basket, helps very materially. A single decayed cherry in the basket will quickly spread the disease to surrounding cherries, thus causing considerable loss by the time the fruit reaches the retailer. To protect himself the retailer has then to put on an extra increase in price to cover the loss from decay and the labour involved in picking over the fruit. A prominent Toronto grocer estimated that fruit retailers have to allow almost 10 per cent. to cover loss from shrinkage and decay before the fruit is finally sold to the consumer. Part of the difference between the returns to the grower and the price to the consumer can then be traced directly to careless grading and packing by the grower.

In distant shipments it is advisable to use the 6-quart basket rather than anything larger. There is less bulk of fruit in one package, with the result that the fruits stands up under shipment better and arrives on the market looking fresher and brighter. The less the bulk of fruit the greater the circulation of air through it, and this helps greatly in reducing loss from decay both in transit or after it has been exposed for sale. For local markets where the fruit is on sale a comparatively short time after picking, the 11-quart basket possibly serves equally as well as the 6-quart so far as the condition of the fruit is concerned, though for a handy quantity of fruit as required by most consumers the atter size is preferable.

Fancy packages, such as the one used in the west for sweet cherries, have been very little tried in Ontario. That there is an excellent opening for such a special trade could it be worked up, there seems no good reason to doubt. The difficulty will be, of course, to get such a trade in home-grown fruit established. A grower in the Niagara district who tried the western carton package has the following to say of his experience: "The cherry season being so short it is a difficult matter to interest merchants who handle fancy packages. I think it could be done if one would make a business of putting up fancy packages of all fruits right through the season."

Varieties.

To the intending planter selection of varieties is a very important matter. A general recommendation as to what varieties to grow would be to plant those

varieties which are succeeding best in that particular district with other growers, and which are most recommended by them. If it is desired to set out other or little known varieties, it would be wise to plant them in an experimental way only until they have proven their growth. Possibly fewer varieties of cherries have been commercially planted in Ontario than any other of our fruits.

Varieties of cultivated cherries are divided into three more or less well-defined groups, the Morello or Sour Cherries; the Bigarreau, Heart of Sweet Cherries; and the Duke varieties, which are intermediate between the other two groups, the fruit being usually subacid.

The following list of recommended varieties for the Niagara Peninsula was approved in 1923 by fruit growers and nurserymen of the district. Other varieties, particularly in sours, might be added for cherry growing sections of the Province where greater hardiness is required. Such varieties are indicated in the descriptive notes of varieties.

Sours.—Early Richmond, Montmorency, English Morello.

Sweets.—Black Tartarian, Napoleon, Schmidtz' Bigarreau, Elkhorn and Windsor.

In addition to this recommended list, several other varieties are noted. Some of these are comparatively new varieties; others are old varieties included mainly to point out their defects, thus indicating reasons for not including them in the recommended list.

Sour Varieties.

Early Richmond.—This is the best early sour cherry on the market. It is a very prolific variety, a regular bearer and hardy, succeeding wherever cherries are grown in the Province. The tree, however, is inclined to be short-lived. The fruit is below medium in size, poor desser quality, but first class for culinary purposes. It is inclined to be a little soft, and keeps only a short while after picking. It is, therefore, a poor shipping variety and should be disposed of in local markets. Season, early to mid-July. Some growers are of the opinion that Richmond interferes with the sale of the Montmorency, a better cherry though later, and that it should not be planted further.

Montmorency.—This variety seems to be the most profitable and therefore the most popular variety. The tree is one of the most vigorous in its class, hardy, very productive, and an early and regular bearer of fruit of excellent shipping and cooking qualities. It is a favourite cherry with the canning factories. It hangs on the tree well long after it is fit for picking, which helps very materially in extending its season so as to prevent a glut on the market at any time. Season, mid-July.

English Morello.—Though not as popular as either the Richmond or the Montmorency, the English Morello should prove a very valuable variety for extending the cherry season well on to the middle of August. It is certainly deserving of wider cultivation in Ontario, having many other good qualities besides lateness of season to recommend it. Unfortunately the tree is a small, slow grower, and should, therefore, be planted closer than most of our common sour varieties. However, it is very productive and an early bearer, though possibly not as early as either the Richmond or Montmorency. The fruit is fairly large, dark red, attractive looking, much too acid for dessert purposes until very ripe, but for all culinary purposes probably unsurpassed by any other variety. In flavour it becomes more and more subacid and agreeable the longer it matures. Like the Montmorency the fruit will hang on the tree, if necessary, in good condition for a considerable time after it is sufficiently mature to pick. The fruit is firm and an excellent shipper. Season, early August.

The three above described varieties, Richmond, Montmorency and English Morello, will cover the sour cherry season fairly well and will not overlap each other in season to any great extent, thus providing a steady and economic output with no uneconomic rush in the orchard at any one time. The season might possibly be lengthened by including Dyehouse to come on just before the Richmond, but it is not as profitable or otherwise as desirable a variety as the later ones. It precedes the Richmond by a very small margin only, and in addition the fruit is small in size. It is not as hardy as the Richmond.

If more or other varieties than the above described are desired, the Orel (Orel 25) and the Russian 207 or Russian Morello could very well be recommended, especially where greater hardiness is required. The *Orel* is one of the hardiest of the Morello or Sour Cherries, and is to be recommended for the more northern limits of cherry culture. Mr. Harold Jones, of Maitland, considers it the best all-round cherry yet tested for cold sections. The tree is rather a slow grower, but an early and abundant bearer of medium sized, good quality fruit for culinary purposes. Season, mid-July.

Russian Morello is a hardy, vigorous productive variety of Russian origin. It is a good cooking variety of ordinary quality and a fair market variety. Season, mid-July.

Sweet Varieties.

There is a wider choice of varieties in Sweets than in Sours and there are quite possibly other varieties than those noted in the recommended list, which are worthy of planting. From a commercial standpoint, however, the fewer varieties required to cover the season the better, hence the short recommended list.

It will be noted in the recommendation that only one white variety, Napoleon, is included. Blacks ordinarily sell for considerably more per basket than whites. All markets apparently prefer the dark or black varieties. Also blacks can be picked when less mature than whites, and they will still colour up properly and sell well. White varieties, on the other hand, if picked immature, will never acquire that slight blush which adds so much to their appearance, but will lack brightness and finish and present a "dead" appearance by the time they reach the retailer. Furthermore, white varieties show the slightest bruises and skin rubs a very short time after picking. White varieties should not be picked until they have acquired their characteristic blush and are full size unless there is danger of losing considerable of the crop from brown rot induced by adverse weather conditions.

Bing.—On the Pacific Coast, where it originated, the Bing is regarded as one of the best sweet varieties. There are few trees in the Niagara District and these are young. Nevertheless they promise well, and there seems no reason why Bing should not eventually become one of our leading varieties. The fruit is extra large, handsome, very firm fleshed, and of the very best quality. Under our conditions the fruit seems inclined to crack rather badly. Tree characters are good, though perhaps the variety is more capricious as to soils than some other varieties. Matures before Windsor.

Black Tartarian.—This is the best early season black cherry, whether for market or for dessert purposes for the home. The tree is vigorous, productive and a very regular bearer. The fruit is of large size and delicious flavour. An objection to the variety is that it is very subject to ravages of birds, probably because it is somewhat soft fleshed. It is also subject to rot in wet seasons, and on this account it is often necessary to harvest and ship it a little on the immature

side. Season, early July. In addition to its commercial value as an early variety, Black Tartarian is probably the best pollinator we have for other sweet varieties. Any new plantings of sweet cherries therefore should include a percentage of this variety.

Early Lyons or *Lyons*.—This variety, while not at all well known, seems to deserve trial as an extra early black. The variety has done well at Vineland. The tree is somewhat slow to come into full bearing, but bears well with age. The fruit is large, handsome, black and of excellent quality. The flesh is somewhat firmer than that of Black Tartarian. In season it precedes Tartarian by several days.

Elkhorn.—This variety is fast proving itself to be one of the most profitable market varieties. The vigour and productiveness of the tree make it a favourite with the grower. It is excellent for both dessert and market, being large, very meaty and firm, and standing up well under shipment. Season, late July, before Windsor.

Governor Wood.—As an early season white cherry this variety has proved itself fairly satisfactory for both dessert and market purposes. It is very productive, and on that account the fruit quite often runs rather small in size, an undesirable feature from a market standpoint. It is, however, of good quality and altogether our best early market variety before Tartarian. Owing to the softness of the flesh the fruit does not stand up under shipment as well as is desirable. Another objection to the Governor Wood is that it comes on the market during the strawberry season, late June, when pickers are scarce, and when also there is not the demand for cherries that there is after the strawberry crop is out of the way. Owing therefore to the several objections to the variety Governor Wood is not recommended for commercial planting.

Lambert.—This is another promising variety of Pacific Coast origin, and worthy of extensive trial in Ontario. It is a vigorous, strong grower and usually productive. Bearing trees in the Niagara District have not been particularly productive. The fruit is very large, black, handsome, and of excellent quality. In season it is medium late.

Napoleon.—Known as *Royal Anne* in the West. It is probably our most productive variety, yielding fruit of large size and good dessert quality which is in fair demand. It is probably the most desirable white variety from a commercial standpoint. Unfortunately, it has one very serious fault, it is very subject to brown rot, especially in wet seasons, when the whole crop may be destroyed in orchards where proper means of control have not been taken. All sweet varieties seem to be quite susceptible to rot, but some varieties, as the Napoleon, suffer more from the fact that the fruit hangs in large clusters. One rotten cherry will infect the whole bunch. As a canning cherry, the Napoleon is esteemed, as it bears cooking well and looks well in the jars. Season, early July.

Pelham.—This variety was introduced by an Ontario nursery some years ago. At the time of its introduction it did not receive much prominence. At the present time, however, it is finding favour because of its extreme late season, maturing when all other varieties are over. The fruit is black, of medium size and quality, and not subject to rot. The fruit stems are extra long. Tree habits are good, and it is a regular moderate bearer.

Schmidtz' Bigarreau or *Schmidtz*.—This variety has been recommended by some growers as being especially adapted to heavier soils, a point in its favour, as it increases the limits of successful sweet cherry culture. It is a very vigorous

black cherry, bearing fruit of large size and splendid appearance, but the tree is usually complained of as not being sufficiently productive. Season, late July, about the same time as the Elkhorn, which on account of its greater productiveness should be planted in preference.

Windsor.—The Windsor is the favourite dark cherry with many growers. Its late season, coming as it does after the Elkhorn is off the market, makes it especially desirable as it has no other variety to compete with it. The tree is not an early bearer, and the fruit is subject to rot in some locations. However, its late season, productiveness and regularity of bearing, excellent dessert, quality, its firm flesh, making it a better shipper than most dark-coloured cherries, and the fact that it will succeed farther north than most Bigarreau or sweet cherries, and under more diverse soil conditions, all tend to make it probably our most valuable variety.

Yellow Spanish.—The fruit of this variety is of large size, a beautiful waxy lustre and delicious flavour. The tree is very vigorous and grows to a very large size, possibly surpassing in this respect any other cultivated variety in Ontario. Like the Napoleon, it is subject to brown rot. It is an excellent cherry for dessert or culinary purposes. However, its season, early July, is practically the same season as Napoleon, so that only one or the other should be planted. The Napoleon, commercially, is probably the more desirable.

Deacon, *Giant*, *Seneca* and *Victor.*—Are four new varieties of which little is known as yet so that no worthwhile estimate of their commercial value for Ontario can be made. Growers who are so inclined may plant a few trees for test purposes.

Dukes.—The Duke varieties that succeed in Ontario seem to have one fault in common: the trees have green and ripe fruit on them at the same time, which makes them undesirable for commercial orcharding, necessitating several pickings instead of one, and so materially increasing the cost of harvesting. The *May Duke* is a fine cooking cherry and is very productive, but is rather tender for distant shipments and inclined to rot in wet seasons. The *Late Duke* is also a most desirable cooking cherry, and is very productive. Its season, which is between that of Early Richmond and Montmorency, also makes it a desirable variety. The Late Duke, and the May Duke which precedes it about two weeks, cover the early part of the season for cooking purposes, while two sour varieties, the Montmorency and English Morello, extend the season for cooking cherries into early August.

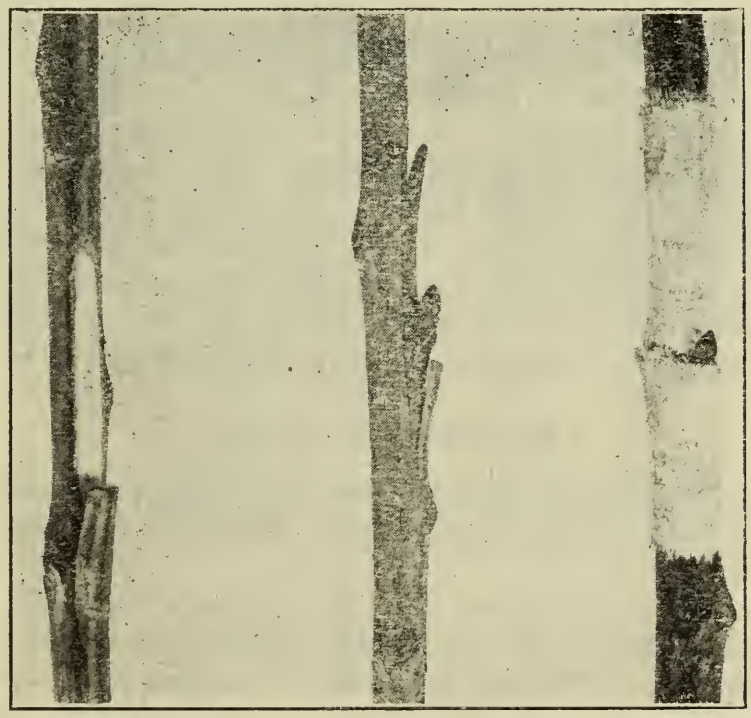
Topworking Cherry Trees.

The more efficient use of cherry trees, particularly some of the sweet varieties, is one problem that is occupying the attention of growers in the Niagara District and other sections of Ontario where this fruit can be grown. This problem is due to various factors such as low yields caused by imperfect pollination, the occurrence of seedling trees which generally produce fruit of small size and poor quality, or the presence of varieties that do not command a good price on the market. Where poor results are due to any of the above-mentioned factors and the trees are healthy and not too old, it would seem desirable to convert them into better trees by topworking with superior varieties. It should be clearly understood, however, that the sweet cherry is not easy to topwork, but by the use of methods developed fair results may be secured. Cherries may be converted by budding and grafting, but budding seems to give somewhat better results. This statement is based mainly on results obtained by growers in the Niagara District and partly on experimental work done at this Station and elsewhere.

In topworking cherry trees, the method of procedure varies somewhat with the size and condition of the tree. Young trees with branches of ⅓ to 2 inches in diameter may be topworked by grafting or budding directly on the branches as they are, but older trees with larger branches should first be forced into vigorous condition of new growth. This can be done by a combination of severe pruning, soil cultivation, and the use of nitrogenous fertilizers. In heading back for this purpose cut off from one-third to one-half of the top growth and if at all possible cut just beyond and close to a good lateral. Large cuts should be coated over with liquid grafting wax or white paint to prevent decay.

Cultivation of the soil will further stimulate growth by destroying grass or weeds and conserving moisture. In addition to this an application of nitrate of soda at the rate of 5 to 8 lbs. per tree according to its size would likely result in a still more vigorous growth.

After a vigorous new growth has been obtained the new branches may be budded or grafted by various methods as desired. Budding is usually done in August, while grafting is done in the early spring, preferably on warm days in March before any sap flow starts.



Various steps in topgrafting sweet cherries by the plate budding method.

Methods of Budding.

The Shield method which is fully described in Ontario Department of Agriculture Bulletin 294, is used with some success. In this bulletin raffia is suggested as a good material for wrapping the buds, but recently it has been found that waxed cotton torn into strips of ¼ to ⅓ inch in width makes a better wrapping material. The waxed cotton is applied by starting below the incision and wrapping around the branch slightly lapping the edge of the material at each turn, and continuing upward to a point above the incision. The end of the waxed strip should be slipped under the last turn or held tightly in place with a small tack. After the wrapping has been applied the bud and any other exposed tissue next to the bud should be coated with liquid parafin wax. The parafin wax should be kept warm enough to flow easily but not so

hot as to injure the bud. A portable oil stove makes a convenient heater for the wax and a small paint brush should be used in applying the wax.

The Plate Bud.

This method is a recent development in the art of budding and is considered by some nurserymen who use it extensively to give better results than the Shield bud. For this method branches of ⅓ to 1 inch in diameter may be used with satisfaction. The branch is prepared for the bud by slicing downward for a distance of 1½ to 2 inches a strip of bark with a thin bit of wood attached. This loose bit of bark is not removed entirely but is cut off about ½ inch above the lower end of the slicing cut.

The bud may be cut from the bud stick by inserting the knife in the bark about 1 to 1½ inches above the bud and slicing downward to a point about ½ inch below the bud or if preferred the cut may be made from below upwards. The knife edge is then turned out and the strip of bark cut off. In removing the bud strip the cut should be deep enough to include a thin slice of wood, particularly under the bud. The bud is then placed by inserting the lower part of the strip underneath the loose flap of bark left on the stock and aligning the edges as closely as possible with the edges of the exposed area on the stock. In cases where the cut on the stock is noticeably wider than the bud strip it would be advisable to insert the bud diagonally across the cut surface so as to be certain of cambium contact. After the bud has been placed it is tied and waxed as described above for Shield budding. As a matter of precaution it is advisable to insert three or four times as many buds as are necessary for the formation of a good frame work, so as to allow for casualties.

In the spring of the following year the branches on which buds grew should be cut off a short distance above the topmost bud of the variety inserted. If more buds grow than are required the least desirable can be removed later on.

Methods of Grafting.

In topworking cherries by grafting various methods are used, such as Cleft, Bark and Whip. All of these methods are described in Bulletin 294 as noted above.

Regardless of the method used special care should be taken to tie the scions in position and also to coat the scions from the lowest point of contact to the tip with liquid parafin wax. The use of parawax is suggested as a means of preventing desiccation, a factor that is almost fatal in cherry grafts. Some authorities recommend the placing of paper bags over the scions as a preventative of desiccation, but the parawax is less costly and easier to apply.

Insect Pests and Plant Diseases.

The cherry in common with other fruit trees is attacked by various diseases and insect pests.

The chief diseases are brown rot, black rot, shot hole fungus and powdery mildew.

The more important insect enemies are cherry fruit fly, plum curculio, pear slug, aphids and San José scale.

For further details concerning the life history and means of control of the above-mentioned diseases and insect pests see Ontario Department of Agriculture Bulletin No. 257, "The More Important Fruit Tree Diseases of Ontario" and Bulletin No. 250, "Insects Attacking Fruit Trees."

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Bee Diseases in Ontario

F. Eric Millen, Provincial Apiarist

Beekeepers are fortunate in that there are few diseases which seriously affect the honey-bee. The diseases which do exist, however, make it essential that their identification and treatment must be certain, if the apiarist is to avoid heavy loss. It is true that one cannot become and remain a successful beekeeper unless the diseases of bees are recognized, and their control understood.

Disease may not appear in the apiary for years, yet finally it may come "like a thief in the night" and the unsuspecting apiarist who is without knowledge of American and European foul brood, may suddenly find the whole apiary worthless and almost an entire loss.

Thus far, adult bee diseases have been rarely found in Ontario and the loss has been almost entirely through the ravages of diseases affecting the developing brood. The brood diseases of bees are: (1) European foul brood; (2) American foul brood; (3) Sacbrood. These diseases are prevalent over a large part of the Province and there is no section of the Province and no apiary outside the range of one or all of the brood diseases.

Identification.

In the control and eradication of any disease, the first step is identification. This is especially true of the three brood diseases of bees. To the unobservant, these three brood diseases are very similar and a mistake in diagnosis, especially when American foul brood is concerned, might be very serious. Before a beekeeper is able to detect any unnatural condition of the brood, it is necessary to know the life history and appearance of healthy brood. Every apiarist should carefully study the life history chart in conjunction with Fig. 1, and be certain that the appearance of healthy brood, in all its stages, is thoroughly fixed in the mind's eye.

*Average Life Cycle of the Honey Bee.

Stage.	Queen.	Worker.	Drone.
Egg	3 days	3 days	3 days
Larva	5½ days	6 days	6½ days
Pupa	7½ days	12 days	14½ days
Egg to adult	16 days	21 days	24 days

As seen in the chart, it is three days before the eggs hatch into larvae and the larval stage lasts from 5½ to 6½ days, depending upon whether the adults are to be queens, workers or drones. It is usually during the larval stage that the symptoms of the brood diseases are recognized, so that this stage is important to the beekeeper. American foul brood is, however, also occasionally found in the pupal stage.

* Beekeeping—E. F. Phillips.

"The egg of the bee is a small white cylindrical object about 1/16 of an inch long, somewhat larger at one end (future head end) and slightly curved. It is deposited on the base of the cell of the comb by the queen and is fastened in place by a secretion."

The larva, at first very small, grows rapidly, and in a few days occupies the whole of the base of the cell. The healthy larva before being sealed lies curled up in the base of the cell and is of a glistening pearly white colour, with the segmentation of the body clearly shown. Before the larva transforms to the pupal

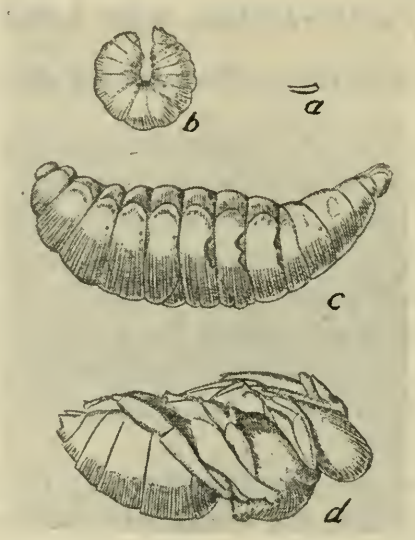


FIG. 1.

The honey bee: *a*, Egg; *b*, young larva; *c*, old larva; *d*, pupa. Three times natural size. (*U.S. Dept. of Agr. Farm Bulletin 447.*)

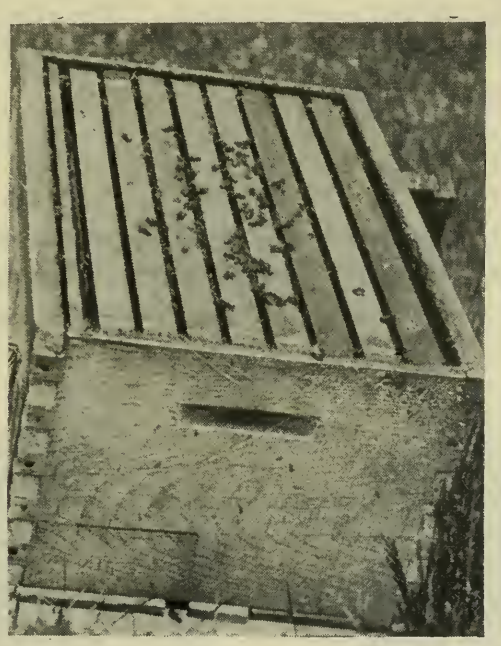
stage, the cell is sealed by the nurse bees and the curled larva straightens out in the cell preparatory to transformation to a pupa. Figure *a* and *b* shows the egg and larval stages before sealed, *c* and *d* the larval and pupal stages after being sealed.

EXAMINATION OF COLONIES.

Although Ontario has a good Foul Brood Act and employs a number of men during the summer for apiary inspection, it is impossible for the inspectors to visit and examine the colonies of all the beekeepers in the Province. This being the case, it is very necessary for every beekeeper to be able to identify the foul broods, so that they can examine their own colonies at the right time. The best time of the year for the examinations are first during the fruit bloom and dandelion period and second during the early part of the fall flow in August. The reasons for the examinations at these times are: First, the bees are gathering nectar, so that robbing is very unlikely; Second, during fruit bloom and dandelion period, disease will usually be found if the colonies have been robbing earlier in the spring, and have secured germ laden honey. The examination in the early fall is also necessary, because at this period we may possibly find infected colonies which either escaped our notice in the spring examination or have contracted disease since. If infected colonies are found, they can then be destroyed, and so save the possibility of the spread of disease in the spring through robbing. These examinations refer particularly to American foul brood. In European foul brood districts, examinations should be made during fruit bloom time and every two or

three weeks thereafter. As will be seen later, however, it is useless to repeatedly examine colonies infected with European foul brood, unless these are properly treated according to the directions given under the treatment for this disease.

When proceeding to examine a colony, the beekeeper should always have the smoker well filled and emitting a dense smoke. After the preliminary smoking at the entrance and on top, the person who is examining the colonies should always sit with back to the sun, so that there is a good light directly on the combs. It is much better to shake the bees from the comb, directly into the



A diseased colony.

A healthy colony.

hive, before the comb is examined. Then if the comb is held slightly below the level of the eyes, a glance will show whether the brood, unsealed or sealed, is normal. The reverse side may then be examined in the same manner. *Before interchanging any frames of brood or honey with other colonies, a thorough inspection examination should be made. This also applies where colonies are to be united.*

Movable Combs.

Beekeepers will see that it is impossible to examine the combs in an immovable-frame or box-hive; therefore, movable-frame hives are essential if the brood diseases are to be controlled. It is also much more profitable from the honey crop standpoint, to keep bees in movable-frame hives. Every beekeeper who has bees in immovable-frame hives should secure the circular on "Transferring Bees," No. 27.

Loss from Disease.

There is an immense annual loss in colonies which die from American and European foul brood. Besides this actual loss, it is impossible to care for an apiary of bees, where American foul brood is present, with uniform manipulations and management. Then again loss may ensue if the apiarist wishes to dispose of the apiary. Besides the loss in honey which is not gathered, fruit growers and those producing clover seed and buckwheat find their crops much reduced when bees are absent.

Value of County Beekeepers' Associations.

The value of a County Beekeepers' Association should be very great in assisting the beekeepers of any county to control and prevent the spread of foul brood. Where there is spirit of unity and good will, the beekeepers of the county are very anxious to eradicate diseases and in this way, those who are not so well versed in either identification or control, receive valuable aid. With a spirit of co-operation also, it is easily possible for the beekeepers of the county to guard each other by preventing the sale of infected apiaries and supplies, also to see that robbing in the late winter or early spring is eliminated. The question of the control and eradication of foul brood should be a part of the Constitution and By-laws of every County Beekeepers' Association.

Moving or Selling Bees or Supplies.

Before colonies of bees or used apiary supplies can be sold or moved from one apiary to another, a permit must be secured from the Provincial Apiarist, O.A.C., Guelph, Ontario. This law applies in all cases, regardless of whether disease is present. See Foul brood Act, at end of this bulletin.

Registering Your Bees.

Every person, in Ontario, keeping one or more colonies of bees, must register his apiary with the Provincial Apiarist each year. See Foul brood Act.

The Brood Diseases.

There are at present three brood diseases of bees in Ontario. They are: (1) European foul brood, caused by the germ *Bacillus pluton;* (2) American foul brood, caused by a germ *Bacillus larvae;* (3) Sacbrood, which is caused by a very much smaller organism known as a "filterable virus."

European Foul Brood.

We shall consider European foul brood first, because the larvae affected with this disease die at an earlier stage than in the case of American foul brood. Before noting the symptoms of this disease, it might be well to state something of the prevalence and spread of this disease. In Ontario we find European foul brood spreading quite rapidly, and at the present time it is found in twenty-seven counties. *Every beekeeper should be thoroughly warned that this disease may appear in almost any apiary in the Province with little warning.* Exactly how European foul brood spreads in the apiary has not been determined. Its infectious nature, however, has been proven, and once the disease appears in one colony, it will spread through the apiary if black or hybrid bees are kept. It will be seen, therefore, that manipulation alone has no effect on the control or eradication of European foul brood.

The symptoms which the beekeeper will find in the brood combs, if European foul brood is present, are clearly shown in the illustrations.

(1) From these illustrations it will be seen that the larvae affected with European foul brood usually die before they are sealed over.

(2) In many cases the larvae die when from two to five days old and instead of appearing a pearly white colour, and in a natural curled position at the base of

the cell, many of the infected larvae begin to assume unnatural positions in the cell as though in pain.

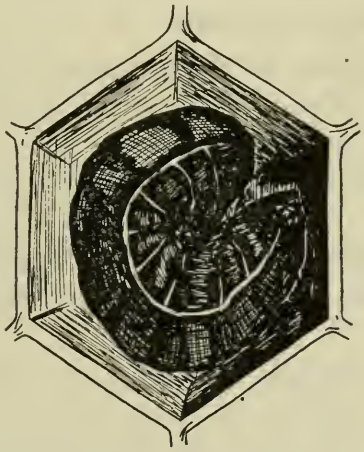
(3) Together with this unnatural position, we find the colour of these larvae changing from a glistening pearly white to a slightly yellow colour, deepening until the dead larvae become a brownish-yellow greasy mass in various positions in the cells.

(4) Other larvae in the same comb affected with European foul brood may retain their spherical or curled shape and position in the base of the cell, but instead of retaining the healthy pearly white colour, they become a grayish-yellow colour, and the tracheae may be clearly seen. These larvae finally turn dark brown.

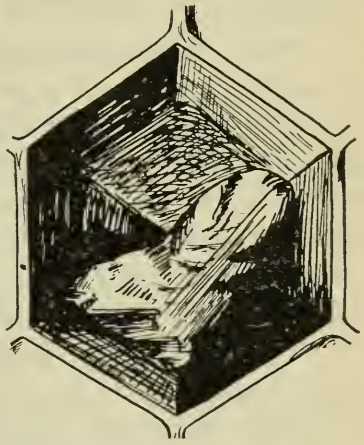
(5) In a few cases dead larvae may be found after being sealed, but these are rare compared with the numbers found in the unsealed cells.

(6) Another peculiarity of this disease is that drone and queen larvae may be affected as well as the worker larvae. This is oftentimes an aid in enabling the beekeeper to determine that it is European foul brood present, rather than American.

Larva attacked by European foul brood in the pre-pupa stage. In cocoon spinning attitude.



Larva attacked by European foul brood showing tracheae.



European foul brood scale. Note irregular position and loose attachment.

(7) If a tooth pick or twig is inserted into one of the dead larvae, which has assumed an unnatural position, it will be found impossible to remove the mass whole from the cell. The skin apparently decays shortly after death. This is also an aid to the beekeeper in differentiating between European foul brood and Sacbrood.

(8) It must be remembered that this test may not be true of those larvae which retain their spherical shape and position in the base of the cell, and which when dead show the tracheae, as these can often be removed from the cell after they have begun to dry.

(9) Another point which may aid in correct diagnosis is that these latter larvae usually die a day or two earlier than those larvae which assume the unnatural positions, and which become a brownish-yellow greasy mass.

(10) The odour from brood which has died from this disease may be very noticeable or may be almost wholly absent. This apparently depends on whether other bacteria are present with the *Bacillus pluton*, so that odour alone is not a constant symptom for diagnosis.

In Farmers' Bulletin 975, U.S.A. Department of Agriculture, Dr. Phillips states "European foul brood is a disease of weak colonies. While at times one may observe larvae dead of this disease in strong colonies, usually they are removed before the disease can do much harm. It should be pointed out further, that it is the colony which is failing to increase in strength in the spring which is most seriously affected, for a small colony which is rich in young and vigorous bees and which is increasing in strength is often able to overcome the disease. It is, therefore, a disease of weak rather than small colonies."

"The disease is prevalent in the spring and early summer. While at times it is observed at other periods of the year, this is not usual. Samples of European foul brood have been received by the Bureau of Entomology in every month of the year, but they are far more commonly received in the early part of the active season. These samples are listed according to the date of receipt at the bureau laboratory. The highest number is received in June and the average date for the removal of the samples from the hives is probably a few days previous to June 15th, perhaps June 10th. The earliest samples received are regularly those from California, where the season opens early. There is a sudden increase in May and June and almost as rapid a decline later. The few samples received from October to April may be largely disregarded as they are almost without exception dried material of unknown age."

"The disease disappears later in the summer unless the colony has become so badly weakened that it cannot remove the dead larvae. Such weakened colonies usually die in winter or in a time of dearth. Colonies do not as a rule die as a direct result of European foul brood. There may still remain some dead larvae in the comb, showing that the bees have not been able to remove all of them, but in any but the worst cases even these disappear. If conditions which commonly prevail in early summer again appear, there may be a recurrence of the disease the same season."

"This appearance of the disease usually accompanies the beginning of the honey flow. At this time, unless the colony has already reached maximum strength, there is a rapid increase in brood-rearing and the colony increases in strength, bringing about conditions unfavourable for the development of the disease. If the honey flow fails, the disease may continue, and under such conditions is at its worst. It should be noted that in regions where the early honey flows are uncertain or usually lacking, European foul brood has done the most damage, for in years of failure the disease spreads with such rapidity that the entire region becomes badly infected. European foul brood is rarely observed in regions where an early honey flow is certain."

"European foul brood is an infectious disease. This was clearly shown by the experience of beekeepers before the disease was investigated from a bacteriological standpoint, and these investigations have supported the observations of the beekeeper. The bacteriological work has shown further, that the disease is caused by an organism which has never been found in any other brood disease of bees. The cause of the disease is, therefore, a specific organism, and the disease is entirely distinct from American foul brood. This is an important point, for there has in the past been considerable confusion in that a few beekeepers have claimed that one disease changes to the other. It should be made clear that this supposition is not supported by any careful observation in the apiary, and that it was recognized generally by beekeepers before the bacteriological investigations were made that the diseases were distinct."

"The organism causing European foul brood does not seem from observations

in the apiary to be so difficult to eradicate as does the one causing American foul brood. This is partially confirmed by the bacteriological observations also."

Preventive and Control Measures for European Foul Brood.

There is no reason why European foul brood should ever cause serious trouble to beekeepers, for it has now been shown that preventive measures can be taken which will make it impossible for this disease to do serious damage in the apiary. The preventive measures include keeping only vigorous Italian stock combined with strong colonies and an abundance of good stores for winter. Beekeepers who have followed this method of beekeeping have found that while there may be an occasional colony in which European foul brood is present, it seldom becomes serious.

Beekeepers who have not yet been troubled with European foul brood should certainly accept the warnings which have been sent out from this office many times in the past, and Italianize every colony with a good resistant strain of Italian stock. While there may be other races or varieties of bees which are resistant, the Italian variety has proven this resistance, and as they possess so many other good qualities, it seems futile to experiment with other varieties. One should also remember that while a good strain of Italian stock may be resistant, occasional colonies of this stock may not have this resistant quality to a sufficient degree, and in this case these colonies should be requeened.

Where European foul brood is already present, measures should be taken to control the disease: first, by making all colonies strong; second, by introduction of vigorous Italian queens. This should be done as early as possible in the season, because, as Dr. Phillips has pointed out, European foul brood is much more serious in the spring and early summer. When securing Italian stock, no attention should be paid as to whether the queens are of the three-banded or golden variety. Colour alone should play no part, but the resistance of the stock to European foul brood should be the main consideration. *It is not necessary to destroy or disinfect combs, brood, honey or supplies where European foul brood is concerned.* At the same time it is a waste of money to attempt to introduce Italian stock to weak colonies when European foul brood is already present. All weak colonies should be united so that a strong colony results and the Italian queen introduced to the united colonies which should now be strong enough to fight the disease.

American Foul Brood.

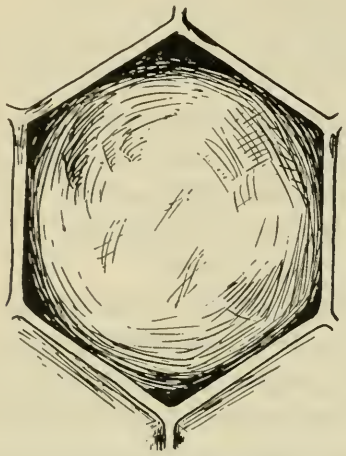
This disease is prevalent over a large area, and at present is found in forty-one counties of the Province. American foul brood differs remarkably from European foul brood, in that apparently it is contagious rather than infectious. One might easily have one or two colonies in a large apiary affected with American foul brood, and yet prevent the disease from spreading to the other colonies, if care was used. On the other hand we find that once American foul brood appears in a colony, it has never been reported to have disappeared without treatment, but gradually destroys the colony affected.

The Symptoms of American Foul Brood.

After the colony has been opened, as previously directed, the brood combs should be carefully examined, and if the sealed brood is healthy, the examiner will notice a uniformity in the shape and colour of the cappings over the brood cells.

This colour may vary from light to deep brown, but there will be a uniform convexity to the cappings which is absent when American foul brood is present.

(1) If American foul brood is present, the examiner will find that here and there, depending on the severity of the disease, in certain of the sealed cells con-



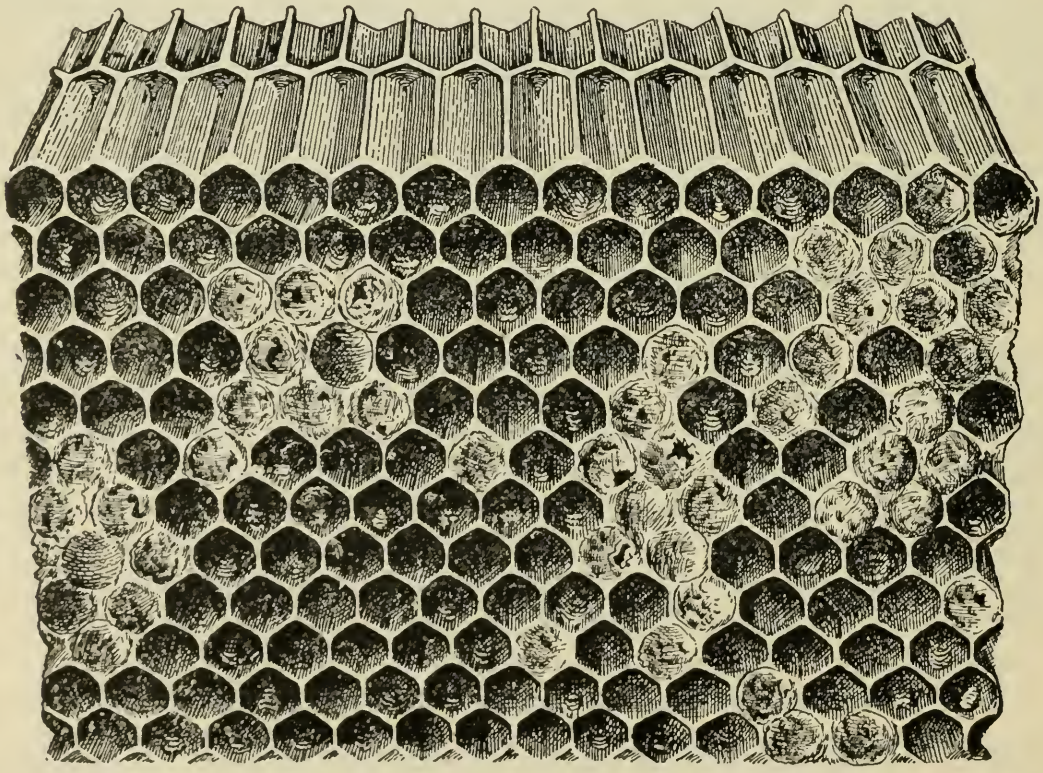
Capping over healthy larva.

Capping over di eased cell. Advanced stage showing perforation. Tongue of diseased pupa is seen through the opening.

taining brood, the cappings will be slightly darker, somewhat sunken or concave, and some cappings may be perforated.

(2) When one sees these sunken, darkened or perforated cappings, one should always remove the capping and examine the larva or pupa in the cell.

If healthy, the larva will be of a pearly white colour or in the pupal stage as illustrated in Figure 1, *d*. If the larva has died from American foul brood, it will

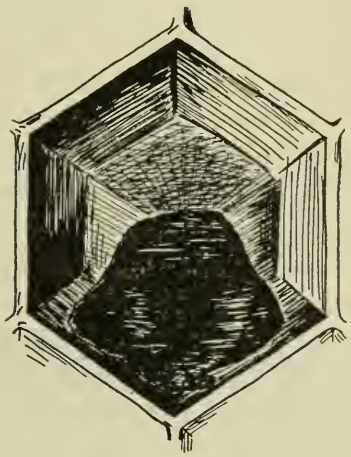


American Foul Brood comb, showing irregular patches of sunken cappings and scales. The position of the comb indicates the best way to view the scales. (U.S. Dept. of Ag. Far. Bul. 442.)

be found that instead of retaining its healthy colour the larva has fallen to the lower sides of the cell, and has become a yellow to coffee-brown colour, and has a varnished appearance.

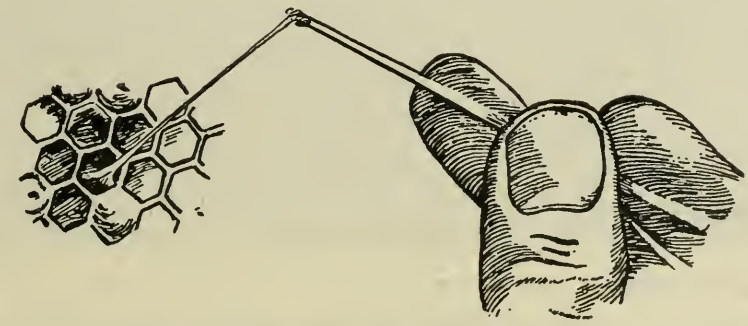
(3) If the inmate of the cell has transformed to the pupal stage, it will have the coffee-brown colour, and usually the tongue will be found fastened to the top walls of the cell.

Brood cell showing pupa affected with American foul brood. Tongue extending to top of cell. Best symptom of American foul brood.



American foul brood scale adhering tightly to cell wall. Caudal end of scale extending up the back of the cell.

(4) If a toothpick or twig is inserted into the dead larval mass, it will be found impossible to remove it wholly from the cell, and a ropiness is noticed when the toothpick or twig is slowly withdrawn from the dead larva.



The ropiness of American Foul Brood
(U.S. Dept. Ag., Far. Bul. 442.)

(5) Larvae or pupae which dies from American foul brood are much more uniform in appearance than is the case in European foul brood.

(6) In almost all cases the dead brood sinks to the two lower sides of the cell wall, and gradually dries to a flattened dark scale. These scales adhere tightly to the cell wall and cannot be removed without tearing the cell wall.

(7) These scales are very noticeable in combs in which the colonies have died during the summer or winter, also when the colonies are badly diseased, and if the combs are held at arm's length, so that the beekeeper can look directly into the cells, he will notice the blackened scales covering the lower two sides of the cell wall, extending to the back of the cell.

(8) American foul brood rarely attacks any but worker brood.

(9) There is a peculiar and constant odour where American foul brood exists which has been likened to that of a poor quality glue. Once identified, this odour will always guide the beekeeper in diagnosis.

Methods of Spread.

American foul brood is spread by robbing, by use of combs and honey from infected colonies, also by the use of infected second-hand or used apiary apparatus, and to some extent possibly, if bees become disorganized and enter the wrong hives. It will, therefore, be seen that the beekeeper can take preventive measures in his own apiary which will prevent the spread of American foul brood. *In all manipulations which call for the exchange of combs of brood, honey or empty combs from one colony to another, the beekeeper should be certain there is no American foul brood present in the colonies so manipulated.*

American foul brood is spread to an alarming degree in the late winter or early spring. Infected colonies weaken or die, and bees from other colonies rob the germ laden honey. *Beekeepers should have all colony entrances much reduced during this period and should also be certain that all colonies are alive. Remove all hives from which the bees have died from American foul brood and burn the combs at once. This is a very necessary precaution in districts where American foul brood is prevalent. Drawn combs should always be kept where bees cannot gain access to them.*

Treatment of American Foul Brood.

As mentioned earlier, so far as is known, once American foul brood appears in a colony it does not disappear unless the colony is treated. It is true that if the infection is slight, it may take two or three years to destroy the colony. The beekeeper should remember, however, that while this is taking place, the infected colony is a source of danger to all healthy colonies within a radius of two or three miles, if the honey from this colony should be robbed by other bees.

To summarize, the treatment may be said to consist of the removal and separation of the bees from the contents of the infected hive. The procedure is as follows:

(1) A new or clean hive is made ready with all but one of the frames containing full sheets of foundation.

(2) To these should be added one dry drawn comb, one in which no brood has been reared preferred.

(3) *This dry drawn comb is placed in the centre of the newly prepared hive, and left until twelve hours after treatment, when it is removed and burned, and replaced with a full frame of foundation.*

(4) Together with this prepared hive, the beekeeper should have an empty hive complete with cover.

(5) After the infected colony has been smoked slightly, it is removed from its stand, and the newly prepared hive, containing the one dry drawn comb and full sheets of foundation, is placed on the stand now vacant.

(6) In front of this hive the beekeeper should spread a newspaper weighted down at the corners with stones.

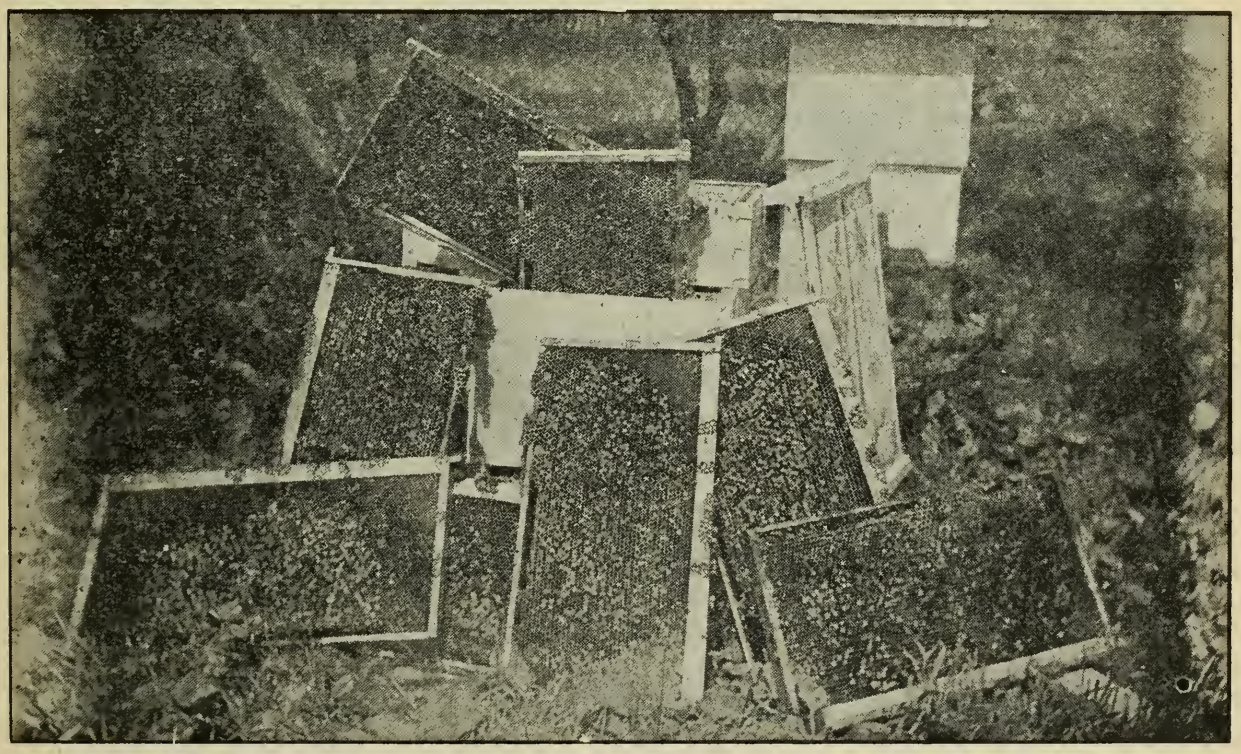
(7) The next step is to transfer all the bees from the infected combs into the newly prepared hive, and this is done by shaking the bees from the infected comb on to the newspaper in front of the clean hive. If necessary a wing or feather can be used to aid the beekeeper in brushing the bees from the infected combs, or the bees can be shaken into a hive-body over the clean hive.

(8) The infected combs should then be placed in the empty hive which is near by and kept covered.

(9) After the bees have been shaken from the infected combs, the beekeeper should dig a hole and burn the infected combs and wing or feather. By this time the bees will have entered the clean hive. The paper on which the bees were shaken should also be burned.

(10) *Twelve hours after the colony has been treated, the dry drawn comb, which was placed in the centre of the clean hive, should be removed and burned, a full frame of foundation taking its place.* It will be found that the bees have stored in the comb, honey which was carried from the infected hive. This is the object of using the dry drawn comb.

As robbing is very serious where American foul brood is concerned, the beekeeper will at once see that treatment must be completed during a honey flow. If the colonies are badly infected and weak, it is much better to destroy colonies.



A Bad Case of American Foul Brood—(*Gleanings in Bee Culture*).

Precautions should be taken to see that the bees from the infected colonies, which are being treated, do not drift to near-by healthy colonies. If other healthy colonies are near and the treatment is completed in the evening, the entrances of these colonies should be closed with screen until the treatment is completed.

It will be seen that no mention has been made of saving the brood or honey from the infected colony, and we do not advocate that this be done, as it has meant the recurrence of the disease in many cases.

Many beekeepers who find an occasional colony affected with American foul brood, prefer to take no chances, but suffocate the colony and then burn the dead bees and contents of the hive. This is a sure cure and the safest treatment.

Where the beekeepers have a large number of colonies infected with American foul brood, the situation is somewhat different, and in this case it might be economical to render the combs into bees-wax. Even then it would

be unwise to attempt to do this, unless the beekeeper could render these combs immediately. Unless this can be done, the saving of combs will be a costly procedure to the beekeeper, and it would be more economical to burn them.

The only 100 per cent. effective treatment for a colony of bees infected with American foul brood is as follows: mark the colonies to receive treatment. In the evening after bees have finished flying, close the entrance tightly and be sure to make the hive bee-tight, now sprinkle one-half to a pint of gasolene over the top bars of the broodchamber frames and replace cover. This will kill the bees. Next take the hive to a good fire, which has been started, in a sufficiently large hole to hold all honey from colonies to be burned. Open the hive and place the combs, one at a time on the fire until combs are burning fiercely, then add the remainder, a few at a time. Remember gasolene has been used, so place combs on fire carefully. After all combs are burned, scatter shavings around the outside of the fire and set alight, to burn any honey that may have been spilled while burning combs. Cover the hole with earth again after fire has burned all frames and wax.

Cautions.

(1) Prevent bees flying from infected colony while destroying with gasolene.

(2) Never start fire near buildings as wax in the combs burns very rapidly and fiercely. Allow for windy weather.

(3) Never start fire in dry grass as fire may get out of control and do much damage.

(4) Never leave fire until it has burned the infected material and the hole filled in with earth.

(5) If you spill honey from infected colony and this honey is not burned, it will probably spread the disease.

Treatment for Infected Apparatus, Except Combs.

After the beekeeper has destroyed his infected brood combs, he should be sure to disinfect the bottom boards, broodchambers, queen excluders, inner covers and inside of outer covers; in fact, any piece of apparatus used in connection with diseased colonies. First scrape all parts clean, being certain to remove all burr comb, propolis, etc., then paint all inside parts with a 20% Formalin Water solution. Queen excluders and other metal appliances can be dipped. The inside of all wooden parts, as hive-bodies and bottom boards, can be lightly scorched, if preferred.

Make a thorough job of disinfecting your possibly infection-carrying supplies.

Directions for Treating Combs with Alcohol-Formalin and Formalin-Water Solutions.

Thus far we are not recommending beekeepers to treat combs containing the scales of American foul brood, except as experimental work and then by experienced beekeepers only. The reasons are: (1) The high cost per comb; (2) A beekeeper rarely has sufficient combs containing scales to make it profitable; (3) We are not yet satisfied that the treatment is a 100% certain cure in all cases. We recommend, therefore, that those brood combs containing the scales of American foul brood be destroyed immediately.

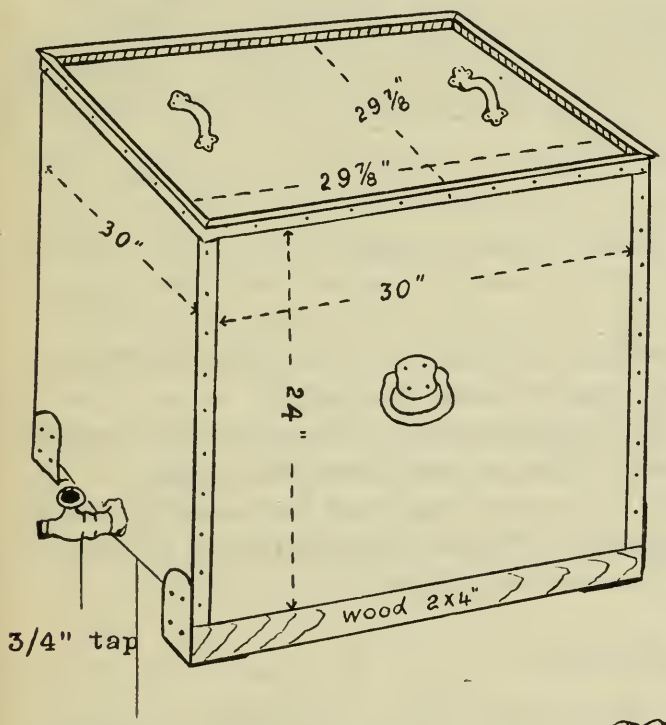
For the treatment of combs with either solution, the beekeeper will require a metal tank. The tank illustrated will hold about 70 combs and a 45 gallon drum of solution will hold enough solution to cover all combs for one immersion. Extra solution will be required to keep drum filled.

Now follow these directions:

1st—Uncap and remove every cell of honey from the combs.

2nd—Wash combs in warm water for a few hours to remove all traces of honey.

Outside view.



Notes

1. Made of No. 20 sheet-iron.
2. Angle iron is used around the top for strength and support.
3. Sheet iron is used to fasten (2 X 4) wood to the tank.
4. The lid fits down into the tank. It is made of sheet iron and strengthened with angle iron around the edge.
5. Height 24".

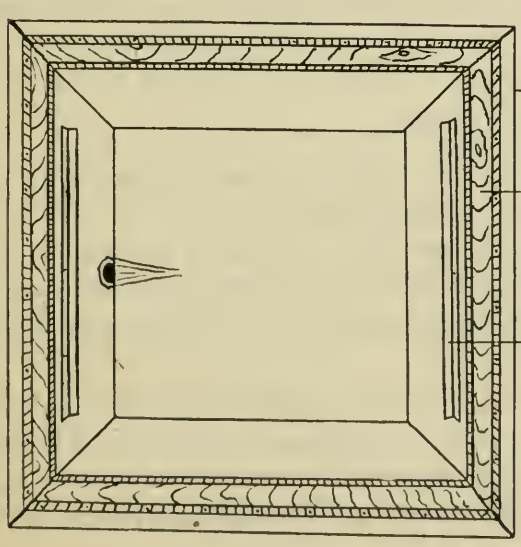
Floor of tank drains towards outlet.

Under side of lid showing angle iron.

Angle iron to support lid and make it rigid.

Reinforced corners.

Looking into tank from above.



angle iron around top.

3/4" wooden rim to support cover

Angle iron to support slats holding down combs.

Treating Tank.

3rd—Make sure that any washings of honey and water from the combs run into the ground or drains so that bees cannot gain access to it.

4th—Place combs in the tank in the position in which they are placed in the hive, or any other position most economical, except upside down.

5th—Be sure the solution enters from the bottom of the tank and covers the top of the top-bar of the top frames. Keep cover on tank to prevent evaporation.

6th—In the case of formalin use 20% formalin to 80% water with 24 hour immersion of combs.

7th—In the case of alcohol formalin do not dilute this solution and immerse combs for 48 hours.

8th—After combs have been treated, run them through an extractor to remove all possible solution. This solution can be used again. Thoroughly wash extractor before extracting any honey. Have extractor as close as possible to tank to prevent waste of solution by drip.

9th—Combs should be thoroughly aired or washed under running water and dried so that all trace of the solution is lost before being returned to the bees.

10th—It will cost approximately 8-10c a comb to treat with alcohol formalin and less than one-half this with formalin water. Do not use the formalin water for any except super combs.

11th—Use rubber gloves when handling solution or wet combs and be sure to have plenty of ventilation to allow formalin odour to escape.

12th—Beekeeper must be certain that solution used is of guaranteed strength and free from poisons. A guarantee should be secured from the vendor.

13th—It is doubtful whether it will pay to treat less than five hundred combs, unless two or more beekeepers share expense. If less than this number of combs, render into beeswax and have this made into foundation.

Sacbrood.

"Sacbrood is an infectious disease of the brood of bees caused by an infecting agent so small, or of such a nature that it will pass through the pores of a Berkefeld filter." (White, U. S. Department of Agriculture Bureau of Ent., Cir. No. 169.)

Sacbrood, with rare exceptions, has not proven a serious menace to the beekeepers in Ontario. It is important because its symptoms are similar to American and European foul brood to the inexperienced beekeeper. For this reason, all who keep bees should be sure that they can identify Sacbrood, so that there can be no danger of a wrong diagnosis.

Symptoms of Sacbrood.

(1) When Sacbrood is present in a colony, the infected dead larvae may be found in both unsealed and sealed cells in the brood frames.

(2) The dead larvae in the unsealed cells, however, are not found in the unnatural positions in which we find larvae which die from European foul brood.

(3) The dead larvae are usually found straightened out in the cell and from a light yellow to a dark brown colour.

(4) If a toothpick or twig is inserted carefully into the cells, the dead larvae can be entirely removed, and resemble a tiny sack, contents of which are watery.

(5) In the case of Sacbrood, the skin apparently does not decay for some time, and it is this fact which makes it possible to remove the larvae whole from the cells.

(6) There is very little, if any, odour in brood which has died from Sacbrood.

(7) Sacbrood, however, is similar to European foul brood, in that queen and drone larvae may be affected as well as the worker larvae.

(8) The coffee-brown colour and ropiness which we find in American foul brood is absent in Sacbrood. As the workers remove the dead Sacbrood larvae, there are no scales. These differences aid in distinguishing Sacbrood from American foul brood.

Control Measures for Sacbrood.

If vigorous queens are kept and good beekeeping methods are practised, Sacbrood rarely needs any other treatment. Where it is present sufficient to weaken the colony, a new queen should be introduced. If the beekeeper is certain that his diagnosis is correct, the disease should disappear soon after the new queen has been introduced. Sacbrood is contagious.

Brood Diseases from Other Causes.

Sometimes brood dies from causes other than the three brood diseases. It is well for the beekeeper to identify, whenever possible, the cause of death, so that if American foul brood is absent, the combs may be used again. In the spring of the year, the beekeeper will often find dead brood in the combs of colonies which died during late winter or early spring. If the brood died through being chilled. (1) It will be found in rather a compact sphere; (2) On uncapping one of the sealed cells, the inmate will often be found in the pupal stage, and dark in colour; (3) In all cases the dead brood can be easily removed from the cell.

This unnatural brood-rearing may be caused through the bees having to generate an excessive amount of heat, because of the smallness of the cluster or from undue excitement. If the beekeeper is sure there are no scales of American foul brood, these combs are fit for further use. Usually where colonies have died from American foul brood, if there are any sealed cells they are not in a compact sphere, but are scattered over the combs. Scales are also present.

Between honey flows colonies often become very short of stores and will then uncap healthy brood, eat a part of the inmate of the cell and carry some of the brood to the outside of the hive. In this case it is easy for the beekeeper to know that there is no disease present, because the remains of the brood will be a healthy colour, and the lack of honey in the hive aids in making diagnosis. There will also be a lack of the symptoms of the brood diseases.

When a colony becomes hopelessly queenless, fertile or laying workers lay eggs in worker cells which develop into small drones. This brood is scattered over the comb, and if the weakened colony should die at this time, the beekeeper might believe American foul brood to be the cause. On uncapping the sealed cells, however, the dead brood is found to be easily removed from the cells. The cappings are also raised more than normal owing to the fact that the drone has developed in a worker cell. The capped cells resemble the nose of a bullet. The final test is the absence of scales which proves there is no American foul brood present.

American foul brood may be present in colonies which have died as a result of some other cause. This means that the examination of the brood combs must be thorough in all cases.

Adult Bee Diseases.

Thus far the Ontario beekeepers have not been troubled seriously with diseases of the adult bees, with the exception of dysentery. There are, however, a few adult bee diseases known, and in some countries these diseases have done serious damage.

Isle of Wight Disease.

"During the last few years many apiaries in England have been ruined by the Isle of Wight disease. As yet no satisfactory treatment has been discovered. Although it is not known to be in Ontario, it is frequently discussed, and the many inquiries received concerning its nature and symptoms warrant a brief account being inserted in this bulletin."

"The following is taken from leaflet No. 253, issued by the Board of Agriculture and Fisheries, 4 Whitehall Place, London, England:

Symptoms:

1. The first symptom noticed is a disinclination of the bees to work. They fly about aimlessly and do not gather stores.

2. A little later they lose their power of flight and are unable to travel more than a few yards without alighting.

3. As the disease progresses the bees are unable to fly more than a few feet, when they drop and crawl about the ground. They may be seen crawling up grass stems or other upright objects, such as the supports of the hive, but they soon fall down and die. Towards night some may be seen gathered in groups, but they usually die before morning.

4. The abdomen or hinder part of the body is often swollen, and the extreme segments or rings droop and are bent underneath the rest of the body.

5. The wings often appear to be disconnected, the upper wings lying flat about the body, while the lower wings stand out from the body as in flight. Sometimes the legs seem affected, and the bees stagger along in their attempt to walk.

6. Finally the whole colony of workers is found massed together in front of the hive or on the ground, except a few which are found crowded around the queen.

7. The field bees are always the first affected. The queen and the brood are not attacked, though "chilled brood" often appears subsequently, owing to there being insufficient bees to keep the hive warm."

If a beekeeper notices colonies showing the symptoms described, the Department of Apiculture, O.A.C., Guelph, would be glad to receive samples of such bees.

Paralysis or Disappearing Disease.

Whether these two are the same disease is not known. In both cases the adult bees act very much as in the case of the Isle of Wight disease. Often the bees in one or two colonies in the apiary are affected, and in a few days, although the colonies are weakened, the disease seems to disappear. This malady appears mostly in the spring of the year, and often during or shortly after a spell of bad weather. Strong colonies and vigorous queens are the treatment recommended. Little is actually known about the cause of this trouble.

Dysentery.

Properly speaking, dysentery cannot be classed as a disease, because so far as is known, the trouble is due to the bees retaining faeces in the intestines for an unnatural period, or from consuming poor quality winter stores, which contain a large percentage of indigestible matter.

It is known that bees normally retain the indigestible portions of the food, consumed during the winter, in the intestines. If, therefore, the winter is longer than normal, or the winter stores are of poor quality and contain a large amount of indigestible matter, dysentery usually results. The faeces are then voided inside the hive, unless the bees are wintered outside and there are frequent flights during the winter months. Dysentery may also be brought about by unduly exciting a colony during the winter period. The beekeeper can always tell when a colony has died from the effects of dysentery, because the combs, frames and inside of the hive are badly stained, as the bees void the faeces inside. The odour is also quite noticeable and consistent.

The combs from a colony which has died from dysentery may be used over strong colonies later in the season, when they will be cleaned. The wood-work, however, should be thoroughly scraped by the beekeeper before giving these combs to the strong colonies.

If colonies suffer seriously from dysentery during winter and survive till spring, they may dwindle rapidly, because of their weakened vitality, and the colonies may die in April or May.

When heavy brood-rearing is continued late in the fall, owing to the season or late introduction of young queens, and the young bees do not secure a flight before going into winter quarters, dysentery will develop. This is more noticeable and prevalent in cellar wintered bees.

Remedies for Dysentery.

If the beekeeper will see that the bees winter on good quality and thoroughly ripened honey and there is no excessive excitement during the winter period, dysentery is seldom troublesome. Many beekeepers feed each colony ten to fifteen pounds of sugar syrup for actual winter consumption. This is good practice where the quality of honey is uncertain and dysentery appears regularly.

Pests of the Apiary.

Besides the brood diseases of bees, there are a few pests which may do considerable damage in the apiary and apiary supplies, unless preparations are made to control them.

The most important of these is undoubtedly the Bee-moth or Wax-moth, *Galleria mellonella L.* The larvae of this moth work in the combs, and when present, will destroy drawn combs very rapidly. These larvae have a preference for brood combs, and in a month or two, if not checked, they will destroy thousands of combs. Practically all beekeepers are acquainted with the adults, which are often found either inside the hives, from which the bees have died, or in weak colonies. *Professor F. B. Paddock gives the following description of the moths:

Adult Bee-moth.

Description.

"Although very familiar to many beekeepers, the bee-moth is yet not definitely known to many who should be acquainted with it in order that they might more readily combat it. Having been a pest for such a long time, it is remarkable that more beekeepers are not acquainted with this pest of the apiary. Perhaps the reason that these moths are not more commonly known is due to the fact that they are seldom to be seen on the wing, except at dusk, unless frightened from their hiding places."

"The Adult bee-moth is about five-eighths of an inch (fifteen millimeters) in length, with a wing expanse of about one and one-quarter inches (thirty to thirty-two millimeters). The moth with its wings folded appears ashy gray in colour but the back third of each front wing is bronze coloured. This wing is thickly covered with fine scales which rub off easily when the moth is touched. On the outer and rear margins of the forewing is a scanty row of short hairs. The hind wings are uniform in colour, usually gray, with traces of a few black lines extending from the

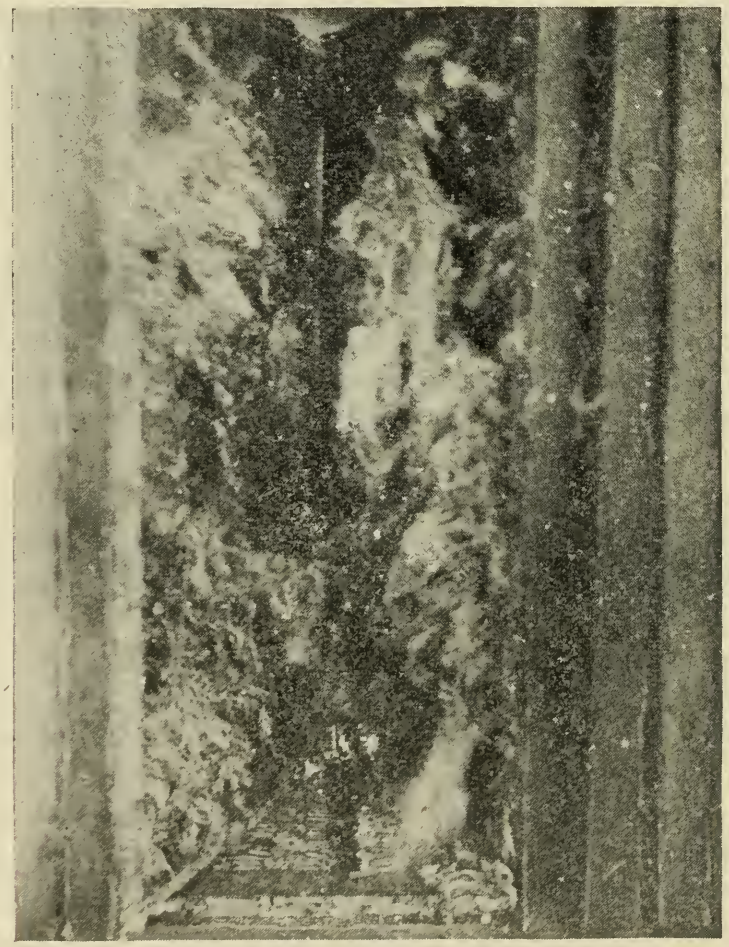
outer margin inward toward the base; on the outer and rear margins is a thick fringe of hairs on which is a dark line running parallel with the border of the wing. The body is brown, the shade varying with a covering of scales. These scales rub off easily and are not always present on the older moths. The male is slightly smaller than the female. A difference between the sexes is noticed in the forewing, which in the case of the male is deeply scalloped on the outer margin. This scallop carries a heavy fringe of hairs, almost black in colour. Another difference is in the mouth parts, the palpi of the male being rudimentary."

In the north this pest does very little damage during the winter, unless the combs are stored in a warm place. From May until October they are active, and it is during the summer months that the damage is done. Their presence is known to the beekeeper by finding the adult moths or the larvae working in the combs. *Professor Paddock describes the larvae as follows:

The Larva of the Bee-moth.

Description.

"When first hatched the young larva (worm) is only one to three millimeters (1-125 to ⅛ of an inch) in length. They have a dirty white waxy colour. The head is slightly yellow and smaller than the prothoracic segment, which is decidedly prominent. The true or thoracic legs



Work of the Bee-Moth Larvae. Combs a mass of webs.

are especially well developed and the pro-legs or abdominal legs are not apparent when the larva is first hatched, and only appear normal when the larva is about three days old."

The larvae when fully grown are ⅞ to 1 inch in length. These larvae work along the mid-rib of the comb, spinning a webbed tunnel as they proceed. If the infested combs are held up to the light their presence is easily seen. Quite often, too, the beekeeper will find the cappings of the sealed brood removed, and the webs of the bee-moth larvae showing. If these webs are removed, quite often the bee-moth larvae can be seen trying to escape. The damage to strong colonies is negligible, as the number of these pests will be controlled by the colony. In the case of strong Italian colonies, they are rarely found, but quite often where black bees are kept, a few of these bee-moth larvae can be found.

*Bulletin 231, "The Bee-moth or Wax-worm," Texas Agricultural Sta.

Wherever the beekeeper finds more than a few of either the adults or larvae of the bee-moth present, it is certain that the colony is either very weak, queenless or diseased.

Remedies

Where the pest is found in living colonies, no remedy is necessary if the colonies are strong. Where the colonies are weak, the beekeeper should remove as many of the bee-moth larvae as possible, and then strengthen the colonies. In the combs from which the bees have died, and where they are badly infested, it is a good plan to close the hive tightly and burn the contents.

Where the combs are not too badly infested, as in the case of super combs, and the beekeeper wishes to save these, Carbon bisulphide is recommended for this purpose. *The following tables by Professor Paddock will enable the beekeeper to gauge the correct amount.

Amount of carbon bisulphide to use in fumigating ten frame shallow supers for the waxworm.

Number of shallow supers in the tier.	Cu. ft. contained in tier.	Amount of liquid bisulphide required.
2	1.74	½ ounce
3	2.61	½ ounce
4	3.48	¾ ounce
5	4.35	1 ounce
6	5.22	1¼ ounce
7	6.09	1½ ounce
8	6.96	1¾ ounce
9	7.83	2 ounces
10	8.70	2¼ ounces
11	9.57	2½ ounces
12	10.44	2¾ ounces

Amount of carbon bisulphide to use in fumigating ten-frame hive-bodies for the waxworm.

Number of bodies in the tier.	Cu. ft. contained in tier.	Amount of liquid bisulphide required.
2	2.90	¼ ounce
3	4.35	1 ounce
4	5.90	1¼ ounce
5	7.25	1¼ ounce
6	8.70	2 ounces
7	10.15	2¼ ounces
8	11.60	2¼ ounces

"For eight-frame supers and hive-bodies, use eighty per cent. as much bisulphide as is given in the foregoing tables for the corresponding number of supers or bodies."

"All fumigation should be allowed to continue for at least twelve hours."

When the beekeeper is using carbon bisulphide it must be remembered that the gas from this liquid is heavier than air, so that the bisulphide is always placed in a vessel inside an empty super on top of the tier of supers. Another very important point is to see that these tiers of supers are air tight as possible, or the fumes will escape before they have killed all the pests. They can be made air tight by pasting a strip of paper around the supers, so that the gas will not escape between the supers.

Carbon bisulphide is very inflammable, and when this is being used, the beekeeper must be very careful that no light is near, or an explosion will follow. It is also well not to breathe any more of the gas than possible, as it will soon cause a headache and sickness if much is inhaled. Professor Paddock states that carbon bisulphide will not injure the eggs of the bee-moth, so that the beekeeper should

fumigate the combs twice, the second time one month after the first fumigation. With the second fumigation, all that is necessary is to uncover the empty super on top of tier of supers of combs, and pour more carbon bisulphide into the dish, without disturbing the supers. Beekeepers should be very careful not to leave combs scattered around in the apiary in the summer. Once the bee-moth secures a hold in the apiary, it will remain for a long period, ready at any time to destroy combs which it may find.

Mice.

Mice are seldom troublesome in the apiary during the summer. At that period of the year they do most damage to drawn-combs if these are stored where the mice have access to them. It is always well for the beekeeper when storing supers of drawn-combs to place metal covers or queen excluders below and on top of the tiers of supers.

If the entrance of colonies, wintered outside or in the cellar, during the winter months are large enough for mice to enter, the beekeeper may lose several colonies. The mice will nest in the combs, and so disturb the colonies as to weaken them materially, if not destroy them entirely. For outdoor wintered colonies, entrances should never be deeper than ⅜ of an inch. Where bees are wintered in the cellar, the beekeeper should take precautions by having traps and poison in the cellar.

Skunks, Etc.

Occasionally beekeepers are troubled by skunks. It is said that the skunks will visit one hive night after night, and in some cases will weaken the colony so that it is useless, and may be destroyed. Where these are present, it is an easy matter to dispose of these pests.

Beekeepers in other countries are troubled with numerous other pests including robber flies, dragon flies, wasps and birds, but in Ontario these latter pests are seldom numerous enough to cause damage.

Precautions

1. Never buy colonies of bees unless examined and guaranteed free from American and European foul brood. Consult the Provincial Apiarist, O.A.C., Guelph.

2. If drawn combs, irrespective of age, are purchased with used apiary supplies, they should be rendered into beeswax, unless positive no American foul brood existed in the apiary from which they came. All super combs should receive Formalin-water treatment.

3. Beware of robbing in early spring. Remove all hives from which the bees have died, to a bee-tight place. Do not use the combs if American foul brood is present. Look for the scales.

4. When treating colonies for American foul brood, be careful not to scatter honey from the infected colony. Always treat during a honey flow. Burn all infected combs and honey or the treatment will be useless.

5. Since honey is one means of transmitting American foul brood it should not be fed to bees, unless its origin and freedom from the germs of American foul brood is known. When in doubt, feed sugar syrup.

6. Both American and European foul brood may occur in the same comb. Make sure your diagnosis is correct.

7. When locating an apiary, locate at least three miles from any other extensive apiary. This means more honey for you and a square deal to the other apiarist.

The Bee Diseases Act.

The diseases to bees, besides being a serious loss to the beekeepers, are causing enormous losses to the country at large. The honey bee has long been acknowledged one of the best pollen distributors that visit the fruit trees, and later flowering bushes that are profitably cultivated for the production of their fruit. They are of equal importance in the production of clover seed and buckwheat. Furthermore, since the apiarist has no means of controlling the flight of his bees, nor that of his neighbours, these diseases cannot be cured unless the beekeepers work together, and to organize and assist the beekeepers to work together the Ontario Department of Agriculture is conducting a very strenuous educational campaign.

The following is a copy of the Act:

AN ACT FOR THE PREVENTION OF DISEASES AMONG BEES

[Including Amendments which came into force on March 11, 1925.]

1. This Act may be known as *The Foul Brood Act.*

2.—(1) The Lieutenant-Governor in Council, upon the recommendation of the Minister of Agriculture, may from time to time appoint one or more Inspectors of Apiaries to enforce this Act.

(2) The Inspector shall, if so required, produce the certificate of his appointment on entering upon any premises in the discharge of his duties.

(3) The remuneration to be paid to an Inspector under this Act shall be determined by order of the Lieutenant-Governor in Council, and shall be payable out of any sum appropriated by the Legislature for the enforcement of this Act.

2*a*.—(1) Every person keeping bees in the Province of Ontario shall on or before the 30th day of April in every year apply to the Minister of Agriculture in writing, signed by the applicant, for a certificate of registration.

(2) The application shall be in such form as may be prescribed by the regulations and shall be accompanied by the prescribed fee for registration.

(3) Every application shall be addressed to the Provincial Apiarist, Ontario Agricultural College, Guelph.

(4) Where a person commences keeping bees after the 30th day of April in any year, he shall apply for a certificate of registration as hereinbefore provided within ten days after coming into possession of the bees.

(5) Every person keeping bees who neglects or refuses to comply with the provisions of this section shall incur a penalty of not less than $5 nor more than $10 and costs.

3.—(1) The Inspector shall, whenever so directed by the Minister, visit any locality in Ontario and examine any apiary to which the Minister directs him, for the purpose of ascertaining if any infectious or contagious disease of bees exists in such apiary.

(2) If the Inspector finds that foul brood exists in a virulent or malignant type he shall order all colonies of bees so affected, together with the hives occupied by them, and the contents of such hives and all tainted appurtenances that cannot be disinfected, to be immediately destroyed by fire under his personal direction and superintendence.

(3) Where the Inspector, who shall be the sole judge thereof, finds that an infectious or contagious disease, not being foul brood of a virulent or malignant type, exists among the bees he shall give notice in writing to the beekeeper, instructing him as to the treatment of such disease and stating the time within which such treatment shall be given, and if at the expiration of such time the diseased colonies have not been treated by the beekeeper in accordance with the notice, the same may be treated by the Inspector and the beekeeper shall be liable to the Inspector for all expenses incurred in such treatment.

4. The Inspector may order the owner or possessor of any bees dwelling in box or immovable frame hives to transfer them to movable frame hives within a specified time, and in default the Inspector may destroy or order the destruction of such hives and the bees dwelling therein.

4*a*. For the better prevention of foul brood, the Lieutenant-Governor in Council may, on the recommendation of the Minister, declare a quarantine of bees at any point within the Province and may fix the duration of such quarantine and all other conditions in connection therewith, and any inspector appointed under this Act shall have full authority to inspect bees in such quarantine when directed so to do by the Minister.

5.—(1) The owner or possessor of an apiary shall not sell, barter, give away or remove from the premises any bees or used apiary appliances or apparatus until he has secured a certificate from the Provincial Apiarist that such bees, used apiary appliances or apparatus have been properly disinfected and are free from disease.

(2) Bees or used apiary appliances or apparatus shall not be imported into Ontario from any other Province in Canada or from any State in the United States of America unless accompanied by a certificate from a provincial or state officer certifying that such bees, used apiary appliances or apparatus are free from any infectious or contagious disease, but this shall not apply to the importation into Ontario of bees apart from combs.

(3) Every person who contravenes the provisions of subsection 1 or of subsection 2 of this section shall be guilty of an offence and shall incur a penalty of not less than $50 nor more than $100.

6. Any person whose bees have been destroyed or treated for foul brood, who sells or offers for sale any bees, hives or appurtenances of any kind, after such destruction or treatment, and before being authorized by the Inspector so to do, or exposes in his bee-yard, or elsewhere, any infected comb, honey or other infected thing, or conceals the fact that said disease exists among his bees, shall incur a penalty of not less than $20 and not more than $50, or he may be imprisoned for a term not exceeding two months.

7. Any owner or possessor of bees who refuses to allow the Inspector to freely examine bees, or the premises on which they are kept, or who refuses to destroy the infected bees and appurtenances, or to permit them to be destroyed when so directed by the Inspector, shall, in the complaint of the Inspector, incur a penalty of not less than $25 and not more than $50 for the first offence, and not less than $50 and not more than $100 for the second and any subsequent offence, and the convicting justice shall, by the conviction, order the said owner or possessor forthwith to carry out the directions of the Inspector.

8. Where such owner or possessor of bees disobeys the directions of the said Inspector, or offers resistance or obstructs him, a Justice of the Peace may, upon the complaint of the Inspector, cause a sufficient number of special constables to be sworn in, who shall, under the directions of the Inspector, proceed to the premises of such owner or possessor and assist the Inspector to seize all the diseased colonies and infected appurtenances and burn them forthwith, and, if necessary, the Inspector or constables may arrest the owner or possessor and bring him before a Justice of the Peace to be dealt with according to the provisions of the preceding section.

9. Before proceeding against any person before a Justice of the Peace, the Inspector shall read over to such person the provisions of this Act or shall cause a copy thereof to be delivered to him.

10. Every owner or possessor of bees, and any other person who is aware of the existence of foul brood either in his own apiary or elsewhere, shall immediately notify the Minister of the existence of such disease, and in default of so doing shall incur a penalty of $5.

11. Each Inspector shall report to the Minister as to the inspection of any apiary in such form and manner as the Minister may direct, and all reports shall be filed in the Department of Agriculture, and shall be made public as the Minister may direct or upon order of the Assembly.

11*a*. The Minister of Agriculture, with the approval of the Lieutenant-Governor in Council, may make regulations,—

(*a*) prescribing the form of application for registration;

(*b*) for fixing the fees to be paid for registration and upon a certificate of registration;

(*c*) for the registration of bee-keepers and prescribing the form of the register and the particulars to be entered therein;

(*d*) for requiring beekeepers to make such returns and to furnish such information to the Department as may be deemed necessary or desirable;

(*e*) generally for the better carrying out of the provisions of this Act.

12. *The Ontario Summary Convictions Act* shall apply to all prosecutions for offences against this Act.

Ontario Department of Agriculture

HORTICULTURAL EXPERIMENTAL STATION

VINELAND STATION, ONT.

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Currants and Gooseberries

E. F. PALMER

The purpose of this bulletin is to give, in as few words as possible, some idea of the extent and importance of the currant and gooseberry industries of the Province, and the most approved methods of culture for the home garden and commercial plantation.

Black currant plantation.

Both the currant and the gooseberry favour a northern climate and do not thrive in hot and dry climates. They are a complete failure in the Southern States of the Union and along the Gulf coast. Ontario seems especially adapted to the culture of these fruits and they can be grown successfully over the greater part of the Province. Some varieties will be found tender in certain districts but there are excellent hardy varieties which will thrive well in the lesser favoured localities.

The public, as a whole, has not been educated to a correct appreciation of these fruits as a valuable addition to the more ordinarily used kinds, and further, as they are among our hardiest cultivated fruits, their value in the northern districts where tree fruits grow with difficulty or not at all, is hard to estimate. Both fruits are easily grown, and this fact together with their value for culinary purposes should insure there being at least a few bushes in every home garden. If the fruits were grown at home when possible, instead of being bought, much larger quantities would be consumed.

Where it is possible then, one cannot do better than grow currants and gooseberries for home use. When it is not possible to grow them the opportunity for the commercial grower comes in, and it is to the commercial grower that the urban population must look. And while the urban population has increased tremendously during the ten years previous to 1911, yet the increase in the production of currants and gooseberries has been only twelve per cent. In other words, the urban population—the consuming population—has increased and is increasing much more rapidly than the planting of these fruits.

Many growers at present claim that the money to be made out of currants and gooseberries is small. In this regard I would like to quote a paragraph from the late Mr. L. B. Henry's address before the 1913 Ontario Fruit Growers' Convention. Mr. Henry spoke as follows: "A few years ago the price of currants went down so low that they became unprofitable. Black currants were selling in 1899 and 1900 at sixty-five cents for a twenty pound basket, and at that time you could not sell red currants at any price. But from that time up to the present, prices have steadily risen until in the last two years we have been getting very fair results from these crops."

There is little doubt that if growers now gave more attention to their gooseberry and currant plantations, the added returns would more than justify the extra outlay. There are no fruits that respond more quickly to good treatment than currants and gooseberries. They will stand a good deal of neglect, but if we want large fruit and productive bushes, we must take good care of them.

There is another point to remember too in connection with planting currants and gooseberries. It is this: that though these fruits may sometimes return comparatively small profits yet they serve or should serve as a "filler-in" crop. That is, varieties should be planted which will mature their fruit when there would otherwise be a slack time in the fruit season. The labour is then profitably employed where otherwise it would practically have to "kill time"—an expensive operation for the grower, constituting an overhead charge on the orchard that is very seldom included in estimates of cost of production, etc.

When commercial growing is undertaken several points have to be carefully considered, chief among which are the facilities for gathering and marketing the fruit. Naturally, a near market is desirable since it reduces the cost of shipping, but where no near market is available, this need not prove the deciding factor in the location of a site as currants and gooseberries, especially gooseberries, will ship long distances with little or no injury. Other small fruits will not begin to stand the same length of shipment.

Origin and History of the Currant.

The currant, as compared with some of our other fruits, is of comparatively recent origin. Before the middle of the sixteenth century it was apparently unknown to cultivation, and it was during the fifty years following that it

appeared in its modern improved form. Further, it is only during the past half century or a little better, that there has been any extensive improvement of the fruit in this country. Previous to this time currants were simply currants and were commonly known as reds, whites, and blacks. During later years, however, keener competition in the markets has brought about considerable improvement both in size of fruit and in quality. Many new varieties have been originated, and are supplanting the older inferior varieties.

The cultivated varieties of the red and white currants are derived from *Ribes vulgare*, a native of the northern parts of America, Europe and Asia. Varieties of the black currants are derived from *Ribes nigrum*, a native of northern Europe and Asia. Although not found in America in the wild state, the European black currant seems to have found no difficulty in adapting itself to our conditions. One variety of black currants, the Crandall, comes from an American species, *Ribes aureum*, better known as the flowering currant. It is however, a different species from the ordinary black currant.

The currant is in all cases a northern plant, found in cool, damp situations, and it objects to any radical change from these conditions. It does not prosper in hot and dry climates, for though the plants may look well, they are comparatively unproductive. Favouring a northern climate as it does, the currant succeeds well over a very wide area in Ontario. For this reason, and also being easy of culture, it is one of the best fruits for home planting. Anyone who has the space should grow sufficient at least for home use.

For various reasons the currant is not so generally used in Ontario as most of our fruits. Few people care to eat it in the raw state as most varieties are too acid for dessert purposes. When cooked, it is usually made into jelly or jams for which purposes it is unsurpassed. In the colder parts of Ontario where tree fruits do not succeed so well, the currant, on account of its hardiness and ease of culture, as stated above, finds considerably more favour.

Origin and History of the Gooseberry.

Like the currant, the gooseberry was apparently unknown to the ancients, and it was probably about the sixteenth century that it was first cultivated in Europe. Since that time a wonderful improvement in the size of the fruit has taken place. The Dutch are thought to have made the first marked improvement, but its present development has been largely brought about in England.

Varieties of English and European gooseberries are derived from the species *Ribes grossularia*, a native of north Europe. Varieties of this species have not succeeded well in America until lately, being very subject to Gooseberry Mildew which was thought to be very difficult of control. The past few years, however, have demonstrated that the mildew can, if properly treated, be successfully combatted.

The American gooseberries are derived chiefly from *Ribes hirtellum*, a species native to America. Concerning the origin and history of our American varieties, W. T. Macoun, Dominion Horticulturist, Ottawa, writes in his bulletin on bush fruits, 1907, as follows:—

"As late as 1846 no cultivated varieties of American species of gooseberries were mentioned by writers, the first reference, according to Bailey, being in 1849, in the *Northern Fruit Culturist*, by Goodrich, where the author writes: 'We have it from good authority that native sorts have been discovered both in New Hampshire and Vermont well adapted to garden culture.' In 1847 the Houghton's Seedling was exhibited at a meeting of the Massachusetts Horticultural Society, this being the first improved form of the native gooseberry of which there is a record.

This variety was originated or found by Abel Houghton, Jr., Lynn, Mass. It is probably a seedling of the native species, *Ribes hirtellum*. The first improvement on the Houghton was the Downing, a seedling of the Houghton, which was originated by Charles Downing, Newburgh, N.Y., and first brought into notice in 1853. It is thought by some authorities to have been a hybrid between Houghton and *Ribes grossularia*, the European species. The Downing is still more largely planted in America than any other variety of gooseberry. This is doubtless largely due to the fact that comparatively little has been done towards improving the gooseberry in America during the past fifty years. The most work seems to have been done by Dr. Wm. Saunders, Director of the Dominion Experimental Farms, the originator of the Pearl, Red Jacket, and many other seedlings and crosses not yet on the market. These varieties were all originated in London, Ont. There is a good field for work in improving the native gooseberries, as there is no apparent reason why the size should not be equal to the best English varieties. The quality of the American varieties is considered by some to be better than the average English gooseberry, but the flavour is not nearly so good as the best English sorts."

The native species of gooseberries in Canada are found growing very far north, so that eventually its culture, as with the currant, will extend to those districts where other bush fruits and tree fruits are too tender to stand the long and severe winter.

The gooseberry as now grown is objectionable on account of its thorns, and though this may seem a trifling objection to many, yet it is an important consideration when picking time comes round. Breeding and selection will, no doubt, in time produce a good commercial thornless gooseberry. An English variety has been recently introduced which is said to be thornless. Also at the Central Experimental Farm, Ottawa, there are several young seedlings which are perfectly free of thorns, though probably it will be some time before a commercial thornless variety is originated from them.

For culture in Ontario, the American gooseberries, perhaps, have most to recommend them, the mildew being the great drawback to the English varieties. American varieties have vigour, hardiness, ease of propagation, and superior quality, being inferior only in size, which selection and breeding should overcome in time. The English varieties, however, have been largely planted of late years, as good methods have proved that the mildew can be effectually controlled. Then, too, the jam factories are taking large quantities of these varieties, and it is probably to this fact mostly, that the stimulus in planting English gooseberries is owing. Also English gooseberries usually bring a higher price on the market on account of their size and fine appearance.

Propagation.

The Currant.—Currants are usually propagated from cuttings. The cuttings should be made about six to eight inches long and care taken to make the base of the cutting square across and just below a bud. This facilitates callusing over of the cut and therefore rooting. The upper cut should be made at least half an inch above the top bud so that there is no danger of the wood drying out past that point. A strong growth is desired from the top bud, and if the wood is cut closer than half an inch, the growth is likely to be weakened.

After the cuttings have been made as described, they may be planted right in the nursery row—the usually recommended plan—or they may be heeled in. Another method, and one which is possibly better than either of the foregoing, is that followed by Mr. J. E. Henry, of Winona. He takes the cuttings in the late winter and stores them in the cellar, thoroughly covering them with damp sawdust which holds moisture better than sand. This covering with sawdust encourages a mass of rootlets to start. Early in the spring the cuttings are set out.

If the method of taking the cuttings in August or the beginning of September and planting right in the nursery row is followed, they will be ready to start a good growth the following spring—providing the fall has been favourable. It is well, however, to cover the cuttings with a strong mulch to prevent heaving caused through intermittent freezing and thawing of the ground. The cuttings are placed six to eight inches apart in furrows about three feet apart, and in a well-drained location where there is no danger of standing water at any time. The furrow should be deep enough so that only the top bud or two of the cutting is above ground. This is important as the more of the cutting there is below ground, the more roots will be formed and the stronger the plant will be. There is also danger of the cutting drying out too much before rooting if too much of it is exposed. Place the cuttings in the furrow in a slanting position and firm

Red currants and corn in a Burlington orchard.

the earth well about them. In a favourable season these cuttings should callus well before winter and perhaps throw out a few roots. During the winter it is advisable to mulch the cuttings well as previously stated. Cultivation should be thorough and should begin as early in spring as possible, and be continued throughout the season.

If the cuttings are heeled in over the winter, they should be tied in bundles and buried upside down with soil to the depth of two or three inches over them. This heeling in upside down induces callusing of the cutting as the base is nearer the surface than if right side up, and gets more heat and air. In a few weeks the cuttings should have callused well, and they may be left here over winter if a little more soil is spread over them to prevent them drying out; or if the season

is favourable, they may be planted out in the nursery; or they may be buried in sand or sawdust over winter in a cool cellar.

A method, however, which has much to recommend it, is that followed by Mr. Henry as already outlined. It involves less labour and handling of the cuttings, and there is no danger, either, of the cuttings becoming harmed through bad weather conditions during the winter. Also, if one may judge from the plantations of cuttings and currants on Mr. Henry's place, it produces plants as good as, or better than any other method.

The Gooseberry.—Gooseberries are propagated by cuttings and by layering. As cuttings are apt to be very unsatisfactory, being hard to start into growth, layering is probably the safer and more satisfactory method. Propagation by cuttings would be essentially the same as for the currant so that it need not be again discussed. American varieties give fairly satisfactory results by the cutting method. Both English and American varieties are sometimes propagated from green wood cuttings in greenhouses.

Where mound-layering or layering, as it is more commonly called, is practised, the bushes should be pruned severely in the autumn. This will induce a strong growth of young wood the following season. Early in July when these shoots have about completed their growth, earth is heaped around and through the bushes. Most of this operation can conveniently be done with the use of a plough. The work is completed by heaping up earth until only the tips of the shoots are above ground. The earth is then well packed leaving a mulch of loose soil on top to conserve the moisture.

American varieties will have rooted well by autumn when the separate plants may be transplanted to the nursery row at once or left till the following spring. English varieties will not be ready for transplanting till the following autumn as they usually take a year longer to root well. As with the American varieties, the plants may then be separated and planted out in nursery rows.

Soil and Location.

Currants and gooseberries are comparatively surface feeding plants, which fact largely determines their soil requirements.

Currants will do well on most soils, but prefer a cool, moist, fairly heavy soil, as their natural habitat would indicate. A rich well-drained clay loam will be found most suitable. Gooseberries require a similar type of soil, though a little heavier and moister. In dry soils gooseberries are apt to suffer from premature falling of the foliage, thus exposing the fruit so that it becomes scalded by the sun's rays. The surface of light soils, unless shaded by trees, gets very hot in summer, which is not best for the fruit as it induces mildew. A northern exposure is to be preferred for both currants and gooseberries as such a location is not so likely to suffer in a dry season. A northern site too, may in part offset the disadvantage of an unfavourable soil.

Some reduction in the intensity of the sun's rays will be found advantageous, especially with gooseberries, shading and the cooler atmosphere helping to control the mildew. A shade which is low or very dense, preventing a good air circulation, is undesirable because this condition aids the mildew. Shade, with good air drainage makes an ideal location for gooseberries. Gooseberries, too, are susceptible to sun scalding. They scald very easily if left out in the hot sun, or if the bushes are very open. Currants and gooseberries therefore often thrive well in the orchard. One of the most successful growers of goose-

berries in the Niagara district has part of his gooseberry plantation in the peach orchard. He considers this block of gooseberries as the most profitable he has, and says that the plants thrive better under the peach trees and bear far better than where the fruit is grown in the open; also the fruit is cleaner and freer from mildew, and the pickers find their work more agreeable in the shade of the peach trees. Further, there are two crops coming off the land—gooseberries and peaches. This shading is, of course, most satisfactory and necessary in those districts, such as the Niagara, which have a much warmer climate than that naturally favoured by gooseberries. Mulching tends to accomplish the same end, since it keeps the soil shaded and cool. The above remarks apply equally as well to currants, which will also be found to do better in shaded locations, especially in the southern parts of our Province.

The same grower, in discussing further his gooseberry plantation in the peach orchard, states that in his experience English gooseberries thrive best on sandy loam soil. This is somewhat contrary to the generally accepted practice, but is likely explained wholly or in part by the shade from the peach trees, which would offset the need of a heavier soil, that is, a cooler soil. The late Mr. R. B. Whyte, of Ottawa, stated that: "Mildew, the great enemy of the English gooseberry in this country, results from planting in sandy soils. The roots of gooseberry bushes run close to the surface and consequently they become scorched. They should be planted in soil that won't heat, such as heavy clay loam." This apparently conflicts with the statement of the Niagara fruit grower, but, as noted above, the shading probably accounts for the difference in opinion.

Planting.

Preparation of the Soil.—Thorough preparation of the soil is necessary before planting currants or gooseberries. They are heavy feeders so that the land should receive a heavy dressing of well-rotted stable manure, be ploughed deep, and subsoiled if necessary. The manure, if well worked in, will help in putting the soil in the desired condition.

Time to Plant.—Fall planting is generally to be recommended as currants and gooseberries start growth very early in the spring. Also they can be planted comparatively early in the fall—September—giving the plants ample time to become established before the cold weather sets in. Spring planting, if done early enough, has few objections, but the trouble is that, there being so much other work to be done at that season, the planting is liable to be neglected until after the plants have started growth. This check will seriously affect the first season's growth.

Distance of Planting.—The usually recommended distance of planting is four feet apart in the rows with the rows six feet apart. Currants are often given a little more room, especially the black currants, which are stronger growers. If it is intended to cross cultivate the land, five feet apart each way will be found a good distance to set the plants. Cross cultivation is commonly only needed at intervals. Allowing the plants plenty of room will facilitate spraying and picking. Planting six by six feet would, perhaps, be a better distance to recommend generally for red currants and gooseberries, and seven by seven feet for black currants.

Mr. J. E. Henry, of Winona, recommends planting black currants nine by five feet and gooseberries eight and a half or nine by three and a half feet in the row. This wider distance between the row facilitates cultivation and spraying. When planted this way, five feet for black currants seems to be the proper distance and also allows eighty more plants to the acre than when planted seven by seven.

The following table shows approximately how many plants to the acre there will be with different distance of planting:—

Distance	Plants	Distance	Plants
3 feet by 5 feet.....	2,900	5 feet by 8 feet.....	1,090
3 feet by 6 feet.....	2,420	5 feet by 9 feet.....	970
3½ feet by 9 feet.....	1,380	6 feet by 6 feet.....	1,210
4 feet by 4 feet	2,720	6 feet by 7 feet.....	1,035
4 feet by 5 feet.....	2,180	6 feet by 8 feet.....	905
4 feet by 6 feet.....	1,815	6 feet by 9 feet.....	805
4 feet by 7 feet.....	1,555	7 feet by 7 feet.....	890
4 feet by 8 feet.....	1,360	7 feet by 8 feet.....	780
4 feet by 9 feet.....	1,210	7 feet by 9 feet.....	690
5 feet by 5 feet.....	1,740	8 feet by 8 feet.....	680
5 feet by 6 feet.....	1,450	9 feet by 4 feet.....	1,210
5 feet by 7 feet.....	1,240	9 feet by 5 feet.....	970

When planting gooseberries under trees, Mr. J. E. Henry, of Winona, recommends the following method. "Supposing that the trees are twenty feet apart, plant two bushes in each tree row, placing the bushes six and one-half feet from each tree with a seven-foot space in the centre. This gives more room than when planted in the open, but the bushes will grow larger in the shade."

Planting.—The soil should be in a fine mellow condition as deep as ploughed and then marked both ways the required distances with furrows in one direction. It is well to make the furrows deeper than the plants are to be set so that a little fine top soil may be placed under each plant. Root prune the plants before setting as the roots are usually more or less bruised and torn from digging out of the nursery row. The plants will root stronger from smoothly cut roots than from jagged and frayed ends. Set the plants a little deeper than they were in the nursery row. Tramp the soil firmly about the roots. It is very essential that this firming of the soil be thoroughly done, as otherwise there is danger of the soil drying out the following summer. Also the soil being in close contact with the roots allows of the plant making a stronger start. After firming the soil, a layer of loose fine earth should be at the surface to act as a mulch and prevent the packed soil beneath from drying out. This mulch also helps to keep the soil beneath cool and moist.

When a few plants only are to be planted for home use, care must be taken to dig a hole large enough so that the roots of the plant may be well spread out. If a spade is just used to pry a hole in the ground and the plant set in that, it cannot be expected to thrive.

Choice of Plants.—Strong, well-rooted, one-year-old plants are as good as two-year-old plants, and cost less money. It is, however, essential to have them well-rooted. One-year-old plants are easily set, suffer less check in transplanting

than two-year plants, and make a better growth than they would during the same time in the nursery row. Two-year plants are quite often the cull stock left at the end of the first year after the best year-old plants have been sold. They are grown for a second year and then often sold as No. 1 two-year-olds.

Subsequent Cultivation.

Conservation of moisture, and coolness of soil, especially for gooseberries, are two very important considerations with these fruits, hence cultivation must be thorough and frequent. Where the climate will permit, a very good plan is to plough the land in the fall, leaving a furrow down the centre of each row to drain off the surplus moisture. This ploughing and also all further cultivations must be shallow, as the currant and gooseberry are both surface feeders. When the plants are young cultivation in the middle of the rows may be fairly deep, but as the roots extend across the rows, and take up practically all of the land, the cultivation will have to be shallower else the roots will likely suffer considerable injury. If this fall ploughing is found to be doing any considerable damage it should be discontinued, and the land worked up with the aid of harrow tooth or spring tooth cultivator. If the land is deeply disked, ploughing may be omitted.

The land should be worked down with a cultivator or disc as early as possible in the spring whether ploughed the previous fall or not. As a rule spring ploughing will be necessary if fall ploughing is not done. Later cultivations should be given, especially after heavy rainfalls, to keep the top soil in a fine, loose condition so as to conserve the moisture and keep the land cool. About a week after the crop has been harvested all cultivation should cease in order to allow the young wood to ripen up thoroughly before winter sets in.

Plenty of moisture and a cool soil are especially important in gooseberry culture so that its cultivation should, if anything, be more thorough than that of the currant. Both moisture and a cool soil are important factors in controlling gooseberry mildew.

Fertilizers.

Currants and gooseberries are gross feeders and must have their food readily available and close at hand, as the roots do not spread far or deeply. Thorough cultivation should therefore be supplemented with liberal applications of fertilizers. Barnyard manure is best with perhaps phosphoric acid applied extra in some form.

Potash may also be useful especially in the case of gooseberries. Recent experimental work seems to indicate that the gooseberry is somewhat different in respect to its potassium needs than other fruits which seldom benefit from its application. The Massachusetts state experiment station found that currants also were benefited from applications of potassium. Manuring need not be heavy, of course, until the plantation has come well into bearing, when annual applications should be made. There is little danger of over-fertilizing the currant or gooseberry plantation; in fact, as usually grown, the fertilizer end of the industry is one of the most neglected. Cultivation and manuring must be thorough if good results are to be obtained from these fruits. They will thrive fairly well under neglect, but there are no fruits that will respond more quickly or fully to proper treatment. Apply well-rotted barnyard manure in the fall and supplement this with a dressing of potash and superphosphate

early in spring, especially if the supply of manure has been deficient. Above all keep up the humus content of the soil either by application of barnyard manure, or by green manuring.

PRUNING.

Currants.—Proper pruning of currants is essential to the production of good crops of high quality fruit. The fruiting habits of red currants and black currants differ somewhat, so that the pruning of one is slightly different from the other. Red currants bear their fruit on spurs from wood two or more years of age, while the black currant bears the most and best of its fruit on wood of the previous season's growth. Hence in pruning black currants we must look to the production of a plentiful supply of young wood, and in red and white currants, two and three-year wood. Older wood produces inferior fruit.

The old plan of training the plants to a tree form is now seldom used. The plants are less productive, and if attacked by the currant borer, the whole plant is destroyed instead of one or two shoots. The bush form plan is the generally used one.

In pruning red currants the object in view should be to practise a system of renewal, having vigorous young growth always coming on to take the place of the older branches as they become unproductive. Branches four and five years of age are less productive and should be removed. Two and three-year wood is the most productive and therefore most desirable.

Some pruning may be necessary at the end of the first year after planting to get the bush into shape and regulate the number of main stems to be left. From four to eight main stems properly distributed will bear a good crop of fruit and future pruning should have in view the maintenance of this number of branches two and three years of age and a few others coming on to take their places. It is safe to plan to keep cut out all wood over three years old. Some growers, according to Card, in "Bush Fruits," recommend that no wood over two years old should be left. Broken branches and unnecessary young growth should also be cut out, or shortened back so as to form fruiting spurs.

The young vigorous shoots that are to take the place of the older canes should be shortened in to prevent the bush from becoming straggly, and to force the development of fruit spurs evenly along its whole growth instead of mostly at the ends of branches. Thus the load of fruit will be more evenly distributed, and the bush will be able to support a large crop of fruit without breaking down.

Pruning may safely be done any time when the wood is dormant though, perhaps, it is well to delay pruning until shortly before growth begins in the spring. This avoids any chance of the wood drying back and, if there has been any winter killing of unripened wood, it can then be observed and cut out. Also buds are easily injured in late spring pruning. Pinching back the young growth is followed in some countries, the object being to develop fruit spurs. In this climate it might have the tendency to force buds into growth that would not become well ripened before winter sets in.

The pruning of black currants varies from that of red currants only in so far as the main object is the production of plenty of one-year wood. Pruning is therefore usually more severe than for the red currant as practically a complete renewal of wood has to be obtained each year. Old growth must be kept well cut out.

Gooseberries.—Mr. W. T. Macoun, Dominion Horticulturist, in his bulletin on Bush Fruits, discusses pruning the gooseberry as follows:—

"As the gooseberry makes much more wood than it is desirable to leave, severe pruning is necessary. English varieties are usually trained to a single stem, but this is not necessary, although the freer circulation of air when trained in this way may help to prevent the spread of mildew. The usual custom in America is to grow the gooseberry in bush form. The bush should at first be brought into a good shape by leaving a few of the strongest shoots regularly distributed to make an open head. Five or six of these shoots are quite sufficient to leave at first. As the bush gets older, new shoots are allowed to grow to take the place of the older ones, as the pruning should be done with a view to having only vigorous bearing wood. Fruit is borne on year-old wood and from spurs on older wood. It usually is not desirable to have any wood more than three years old. The best time to prune is in the autumn or winter. The weakest young shoots should be cut off at the ground, also all the stronger shoots not required for fruiting or to take the place of the older branches to be cut away. The side shoots from the older branches should be headed back or cut out altogether so as to maintain a fairly open head, making it as easy as possible to pick the fruit and yet leave sufficient wood to produce a good crop and to shade the fruit from the sun, as in a hot, dry time gooseberries are liable to be injured by scalding. When branches are more than three years of age they should be removed to make way for younger wood. It is advisable to cut out all branches which touch the ground as there will then be a better circulation of air, and the fruit will be kept off the ground. Gooseberries will often begin to bear the second year after planting, but there will not be a full crop until the fourth season. If the soil is kept in good condition by an annual application of well-rotted barnyard manure in the autumn, harrowed in the following spring, and if the bushes are kept sprayed and well pruned, the plantation will not need to be renewed for many years."

The important point to remember is that the finest fruit is borne on the young wood. After two or three years of bearing the wood begins to fail and produces inferior fruit in smaller qualities. There should always be strong, vigorous growth coming on to take the place of the older wood as it is cut out. Also excessive sunlight induces mildew, as well as scalding, and in pruning this point should be carefully borne in mind. The bush must be kept fairly open to facilitate picking, etc., but at the same time the fruit thrives better where it is shaded from the direct rays of the sun.

Renewal of Plantation.

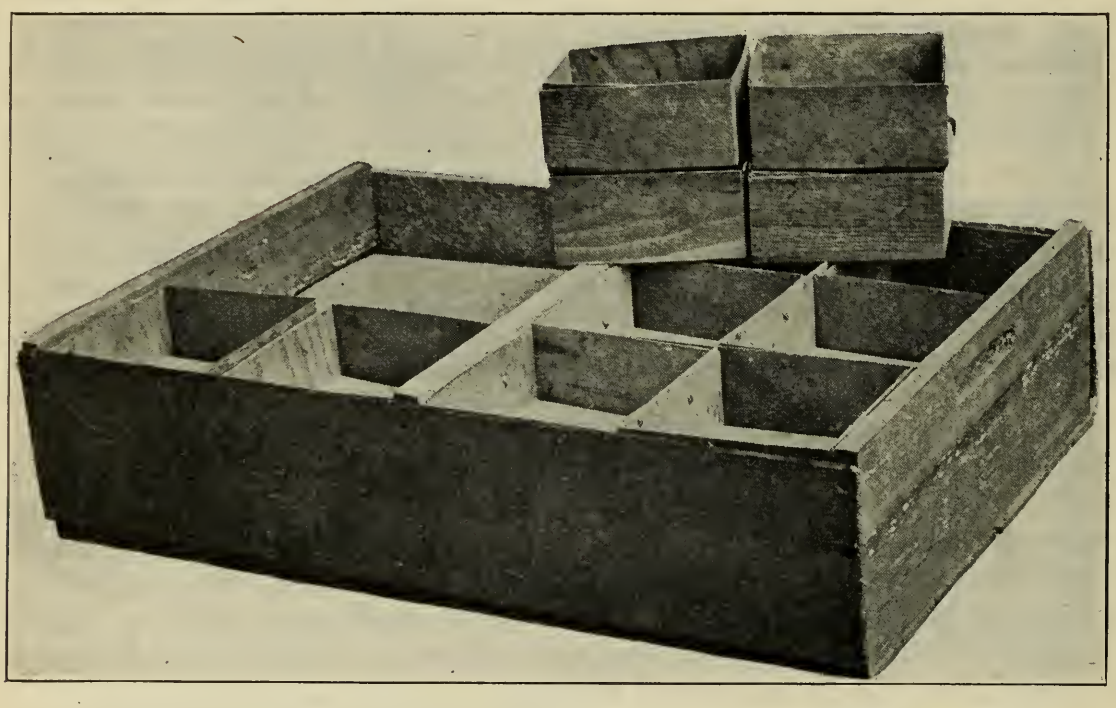
In commercial planting it is usually recommended to renew plantations of both currants and gooseberries after eight to ten years. The bushes will live and bear much longer than this, but they will not be as vigorous and bear as much or as fine fruit as younger bushes. However, with good care, liberal fertilizing, and proper pruning, bushes may be kept in a profitable condition for many years.

It is a safe rule to replant as soon as the first trace of waning vigour is detected. The advantage of young and vigorous plants will more than repay the cost of replanting. Bushes in the home garden may be renewed and reinvigorated by cutting back to the ground and manuring heavily.

Picking.

In picking red currants care must be taken to see that the pickers do not strip the fruit off the stem, leaving the stem attached to the bush. When the fruit is stripped off in this manner, the skin is often broken and the fruit quickly spoils. Pickers should be instructed to take the whole bunch off intact. Varieties of currants which have a long clear space of stem at the base of the clusters, as for example, Fay, have quite an advantage, as they are easily picked without crushing any of the fruit. Black currants are usually picked by stripping the fruit, leaving the cluster stem on the bush.

The thorny nature of the gooseberry bush complicates the picking of the fruit to some extent, and apart from making the picking a more or less disagreeable task, it increases the cost of the operation. When picked green, the fruit may be stripped off, the picker wearing gloves to protect the hands. After stripping, the fruit is run through a fanning mill to clean out the leaves. Ripe fruit is too easily crushed to be gathered and cleaned in this manner. The berries must be picked singly. For jam-making gooseberries are picked as soon as they reach full size, but before they begin to soften—"hard ripe."



24-basket crate commonly used in British Columbia for shipping currants.

Currants and gooseberries should never be picked when they are wet, as if packed and shipped in that condition they will soon spoil. For near markets currants should not be picked until almost fully ripe, while for a distant market, the fruit should be picked while still firm, though coloured.

Yields.

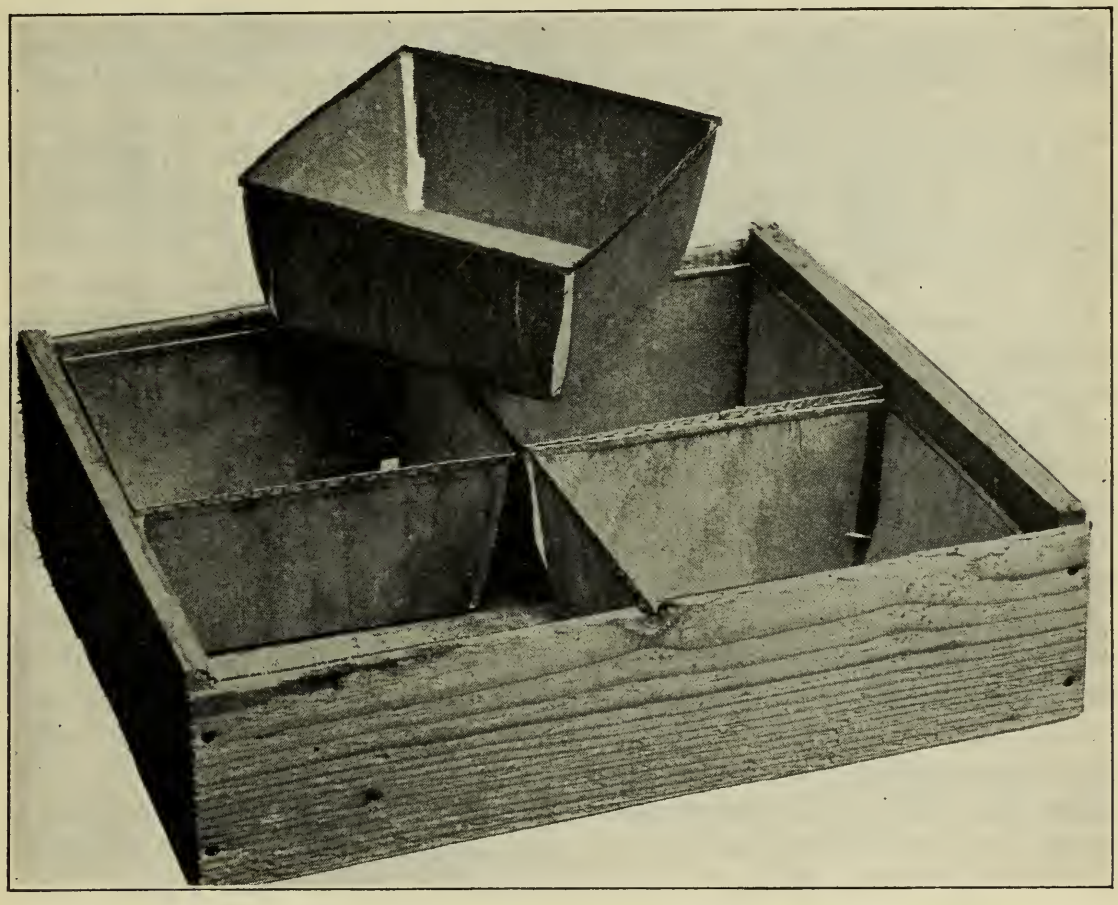
Bailey, in his Farm and Garden Rule Book, gives the average yield to be expected from currants and gooseberries at 100 bushels per acre. For gooseberries this seems very low.

In his book on bush fruits, Card estimates that under proper management the currant ought to yield from 100 to 150 bushels per acre, while he records a yield of 320 bushels per acre. Such a yield is, however, out of the ordinary, and should not be taken as a basis for estimates.

Mr. W. T. Macoun, of the Central Experimental Farm, Ottawa, states that the Rankin's red currant, the largest yielder with them, averaged for four years at the rate of 8,107 lbs. or over 202 bushels per acre. The Red Dutch averaged over 183 bushels to the acre, the Saunders black currant 163 bushels, and the Kerry 159 bushels per acre.

With gooseberries, Card estimates that full-grown vigorous plants ought to yield from five to eight quarts per plant, or roughly speaking, from 300 to 500

bushels per acre, with plants four by six feet apart. At the Central Experimental Farm, six bushes of Pearl Gooseberry have averaged, over a period of five years, at the rate of 310 bushels per acre, while the highest individual yield for Pearl was estimated at a rate of over 680 bushels to the acre. These bushes were planted six feet by four. Houghton, at the Cap Rouge Station, Cap Rouge, Que., planted six feet by five, in 1919, gave the highest yield of 150 pounds 4 ounces from six bushes, or over 909 bushels to the acre.



Crate commonly used in British Columbia for shipping plums and prunes. Used also for shipping currants and gooseberries. Dimensions, 15¾ x 4¼, to hold four veneer tin-top baskets as shown.

Mr. J. E. Henry, of Winona, states that their Whitesmith patch of 600 bushes planted in the peach orchard averaged six quarts each, or 112 bushels for the whole patch. Estimating this per acre, plants five feet by seven, the yield would be about 230 bushels. The figures are not as high as those given by Card, but are mostly actual figures, and therefore entirely reliable, and indicate what yields may be expected under intelligent and proper management.

Packages.

Currants and gooseberries are usually sold in the eleven quart baskets, and for local markets such a package will suit. For long distance shipment, however, currants should be put in packages where there will not be such a great bulk of fruit together as in the eleven quart basket. If packed in the Pacific Coast twenty-four box crate, they would carry much better and arrive in a much more satisfactory condition. Gooseberries may be shipped to the west satisfactorily in the eleven quart basket. Two types of fruit packages commonly used in British Columbia for shipping currants and gooseberries are shown in the accompanying illustrations.

Varieties.

The selection of varieties is an important point and should be given careful consideration. Some varieties succeed well in some localities and are highly recommended by the growers of that district, while they are looked upon as a more or less failure in other localities. It is well, therefore, when deciding upon what varieties to plant to make careful enquiry as to what varieties are succeeding best for that district. For example: Mr. Macoun has found that the red currants of the Fay type are too tender for the Ottawa district. The Versaillaise, Fertile d'Angers, Fay, Cherry, and Wilder, amongst others, have all been found to suffer from injury to the buds during winter.

No technical descriptions of varieties will be attempted in this bulletin, the commercial value only of the different varieties being considered. For technical descriptions the reader is referred to "Fruits of Ontario," published by the Department of Agriculture.

Red Currants.—The usually recommended varieties of red currants for Ontario are: Cherry, Fay, Red Cross, Victoria and Wilder, and to this list might be added Greenfield (recommended by Mr. W. T. Macoun) and Perfection.

Of the above varieties the *Cherry* and *Fay* are probably the most extensively grown in Ontario. They are very similar in appearance except that the bunch of the Cherry is more compact. The stem of the Fay is longer than that of the Cherry, thus facilitating picking. Both are heavy croppers and very desirable varieties.

The *Wilder* is largely planted in the United States, and is highly thought of there, but is comparatively little planted in Ontario as yet. It is certainly worthy of more general planting in this country for the milder districts. It has been found tender in fruit bud at Ottawa. Its mild flavour and good quality make it an excellent sort where a table fruit is desirable.

The *Red Victoria* is one of our best currants for all round purposes. It combines long, well-filled bunches of good-sized fruit of medium quality with hardiness and productiveness. It will succeed well where Cherry, Fay and Wilder would be tender.

The *Red Cross* is one of our newer varieties. It is becoming popular for market and home use on account of the large size of the fruit and its productive habits. An objection to it is that the bunches are of only small to medium size.

Perfection and *Greenfield* are comparatively little known, though they are two very promising varieties. The Perfection is a strong grower, though reported to be rather slow-growing when young. It is a very productive variety bearing exceedingly bright, attractive-looking fruit of very large size in well-filled clusters. It should prove a very desirable and profitable variety for home and market purposes. The Greenfield, originated by S. Greenfield, Ottawa East, Ont., is described by Mr. Macoun as being a productive variety of very large fruit, well-filled bunches, quality above medium. Mr. Macoun, in recommending it, says: "I do not know whether it could be obtained in the trade, but we could supply cuttings to anyone who might write for them."

The *Prince Albert*, a late variety, bearing fruit of medium size in long, well-filled bunches, should perhaps be included in the above recommended list. It is a good late variety and would be found useful in lengthening out the season.

White Currants.—Except for home use, the planting of white currants is not to be recommended, as there is practically no demand for them on the market at the present time. The *White Grape* variety will be found excellent

for home use, being mild and of very good quality. For eating out of hand it is one of the most desirable varieties, whether red or white.

Black Currants.—Black Victoria, Champion, Lee, Boskoop Giant, Saunders and Naples are the usually recommended varieties. Mr. W. T. Macoun considers that five varieties, Kerry, Clipper, Eclipse, Climax and Collin's Prolific, which have been under observation at the Central Experimental Farm, are equal to or better than the varieties generally planted throughout the Province. The first four of these were originated by Dr. William Saunders from seedlings which he took from London, Ont., to the Central Experimental Farm at Ottawa, in 1887.

The late Mr. L. B. Henry, in discussing the varieties of black currants before the 1913 Fruit Growers' Association Convention spoke as follows: "As regards black currants, I only grow one variety, having found it to be the best with us, that is the *Black Naples*. It is a strong and vigorous grower and is very prolific. The buds are borne on short clusters and very well distributed over the bush.

"The *Champion* is not so vigorous. It comes in about five days to a week later than Naples and this may be a point in its favour, as it can be planted along with the Naples and will make a yield that will surprise you. But we have found one fault with it—the fruit does not ripen evenly; that is to say, the fruit may be ripe on some parts of the bush and partly green on the other sections and for that reason it requires more time to pick the fruit properly.

"The *Victoria* is another black currant which is very well known. It is very vigorous, perhaps more so than any other variety I have mentioned, but in our district it is not as heavy a cropper as Naples or Champion. I have no doubt some of you will think that is wrong, because I have heard that Victoria in some districts is one of the best currants there."

The Victoria ripens unevenly like the Champion and is also of late season, though not quite as late as Champion. The fruit is large, but in medium-sized clusters only.

The *Boskoop Giant* black currant has been attracting considerable attention of late, and if it lives up under general culture to advance promises, it should prove one of our most valuable commercial varieties combining, as it does, size and quality of fruit, size of bunch and productiveness. It is most highly commended by growers who have given it a good test. There are indications that it is somewhat capricious as to soils.

The *Saunders*, another of Dr. Saunders' seedlings, is a most promising commercial variety, and has been under general culture for some years now. It is a very productive variety and a strong grower.

Kerry is considered by Mr. Macoun to be one of the most promising for commercial purposes on account of its great productiveness and quality of fruit. *Clipper* and *Climax* are also strong growing productive new varieties of medium to late season, and with *Eclipse*, an early season currant, are very highly thought of at the Central Experimental Farm, Ottawa. In a table Mr. Macoun has worked out, based on the productiveness of the different varieties of black currants, Kerry ranks first, Saunders second, Topsy third, Ontario fourth, Magnus fifth, Eagle sixth, Black Grape seventh, Climax eight, Schwarze Traube ninth, and Clipper tenth. It is worthy of more than passing notice that the usually recommended varieties all come below the ten mentioned above in productiveness based on the yields for fifteen years, '1904-15-17-18-19. Locality, of course, might have something to do with this low showing of these varieties,

though Mr. Macoun thinks not, but thinks the newer varieties, Kerry, etc., are simply better.

If Kerry, Clipper, Eclipse and Climax cannot be obtained from any of the nurseries, cuttings can be secured from the Central Experimental Farm, Ottawa. Collins' Prolific has been on the market for some time, and is considered one of the best commercial late varieties, though, quality and productiveness combined, it is not equal to the former varieties.

GOOSEBERRIES.—Pearl, Downing, Red Jacket, Smith's Improved, of the American varieties, and Whitesmith, Industry and Keepsake, of the English varieties, are generally considered to be the best.

The *Pearl* and *Downing* gooseberries are very similar in size and appearance, the Pearl averaging perhaps a little larger. These two and the *Red Jacket* or *Josselyn* are the three most popular gooseberries of American origin. They are all free from mildew, vigorous and very productive. The Downing is probably the most widely planted in Canada. The *Smith's Improved*, a seedling of Houghton, originated on the American side and is well recommended by American growers. It is not as well known in Ontario as the Pearl and Downing, but is highly spoken of by several Canadian growers. J. E. Henry highly recommends it, placing it before Red Jacket.

Two new varieties worthy of notice are the *Clark* and the *Poorman.* The Clark gooseberry is a variety which was obtained from Burlington, Ontario, and ranks first among the varieties grown at the Horticultural Experiment Station. The berries are of larger size than either Downing or Pearl The bushes are very prolific and are able to withstand drought much better than the other varieties under the same conditions. It is a variety well worthy of extensive planting for commercial purposes. In fact in Experiment Station tests it has proven superior in every respect to all other varieties under test.

The Poorman has not been grown here as yet except experimentally, but it is highly spoken of in New York State where conditions are very similar to ours. Farmers' Bulletin 1024, Washington, gives the following description of Poorman: "Fruit the largest of American varieties, brilliant red when mature. Bush very vigorous, productive; thorns shorter and fewer and less objectionable than those of other varieties. In New York and Utah, it is considered the best of all varieties. Promising for all parts of the United States."

Houghton, an American variety not included in those recommended, is a very productive variety of good quality, sweet-flavoured fruit, and until the advent of the Downing, it was the most popular gooseberry. The fruit, however, is small, though it is a very hardy variety and perhaps should therefore be included in the recommended list. It will thrive where many of our otherwise better varieties will suffer from the severe winters, probably being the only variety of merit that will thrive in the Prairie Provinces.

The *Whitesmith* is probably the best of the English varieties grown to any extent in Ontario. It, and *Industry*, are commonly supposed to be freer from mildew than other English varieties. The experience of Mr. Macoun was that they both mildewed rather badly at Ottawa. Thorough spraying, however, will control the mildew.

THE MORE IMPORTANT DISEASES OF CURRANTS AND GOOSEBERRIES.

J. E. Howitt, Department of Botany, Ontario Agriculture College.

Powdery Mildew of the Gooseberry (*Sphaerotheca mors-uvae*).—This is particularly a disease of the European varieties of the Gooseberry, and is one of the greatest obstacles to the growing of these varieties in Ontario. It

Powdery Mildew of Gooseberry. (After Close.)

attacks American varieties, and currants also, but seldom does them much damage.

The disease first appears on the young leaves and tender tips of gooseberry bushes as a white powdery mildew. This may spread over a considerable portion

Currant Anthracnose on Leaf. (After Duggar.)

of the bush and cover the young fruits soon after they are formed. Later, this white powdery mildew becomes dark brown, forming a thick felty coating over the affected parts. As a result of the mildew the twigs are stunted and fruits dwarfed and rendered useless. Sometimes nearly a whole crop is ruined.

The mildew is spread during the summer months by means of numerous spores produced upon the surface of the affected parts. Later in the season another form of spores is produced on the affected leaves. These serve to carry the fungus over the winter. Warm weather accompanied by frequent showers appears to favour the development of this trouble.

Prevention.—Spray with commercial lime sulphur. The first application should be given shortly before the buds begin to burst, using one gallon to nine or ten gallons of water. The second application should be given soon after the leaves appear, but before the blossoms open, using one gallon to forty gallons of water. In wet seasons it may be necessary to give a third spraying after the fruit is set and a fourth about ten days later, with the same strength as recommended for the second application. Care must be taken to see that the spraying is thoroughly done so that every part of the bush is covered. Supporting the plants or pruning them so that the branches will not rest on the ground also aids in the control of this disease.

Anthracnose of Currants (*Pseudopeziza ribis*).—This is a troublesome disease of red and black currants. It is also sometimes seen, to a slight extent, on gooseberries. This season is recorded as being worse on red currants but, here in Ontario, however, in some seasons it is just as bad on black currants.

Currant leaves curled by aphids. (After Close.)

It causes spots on the leaves, young canes, fruit stems and fruits. The spots on the leaves are the most conspicuous symptom of the disease. These are small brown spots which are often very numerous. If these spots are examined carefully little cracks or fissures will be seen in them. Badly infected leaves turn yellow and drop. The chief damage is the early defoliation of affected bushes, which may take place as early as the end of July.

The disease is spread during the summer by means of spores produced in the little cracks or fissures in the spots on the leaves. It is carried over the winter in the fallen leaves and probably also to some extent on the canes.

Prevention.—Both Bordeaux mixture and lime sulphur have been recommended for the control of this disease. The results of experiments conducted by Prof. Caesar in 1919 show that Bordeaux mixture is much the better fungicide for this trouble. Spray with commercial lime sulphur, one gallon to eight, just when the buds burst. This is a dormant, cleansing wood spray to prevent San José Scale. For the other applications use standard Bordeaux mixture. The second spraying should be done just before the bloom; the third spraying just after the fruit is set and the fourth spraying about two weeks later on black currants, and just after the fruit is picked on red and white currants.

Leaf Spot of Currants and Gooseberries (*Mycosphaerella grossulariae*). —This disease attacks currants and gooseberries. It is usually most troublesome on black currants. The chief symptom is a spotting of the leaves. The spots are at first brown, but later become pale or gray, and, if examined with a hand lens, little black specks (the fruiting bodies of the fungus) may be seen in them. Badly affected leaves turn yellow and drop. In severe attacks the bushes may be completely defoliated early in the season.

Prevention.—Spraying as recommended for Anthracnose of Currants will prevent this disease.

European Currant Rust (*Cronartium ribicola.*)—This disease affects gooseberries and currants, but appears to injure black currants only. In Ontario in wet seasons, many black currant plantations have been almost completely defoliated by this disease. Such defoliation occurring as it does several weeks before the normal time, must of necessity lower the vitality of the bushes. The disease is seen on the lower surface of currant leaves as little clusters of yellowish-red or orange-coloured spots. These may be few and scattered or numerous and close together, depending upon the severity of infection. Later they are replaced by elongated, thread-like or horn-like, dark, reddish-brown structures. If these are numerous they give the under surface of the leaves a felt-like appearance, and hence the name "Felt Rust of Currants" has been suggested for this disease.

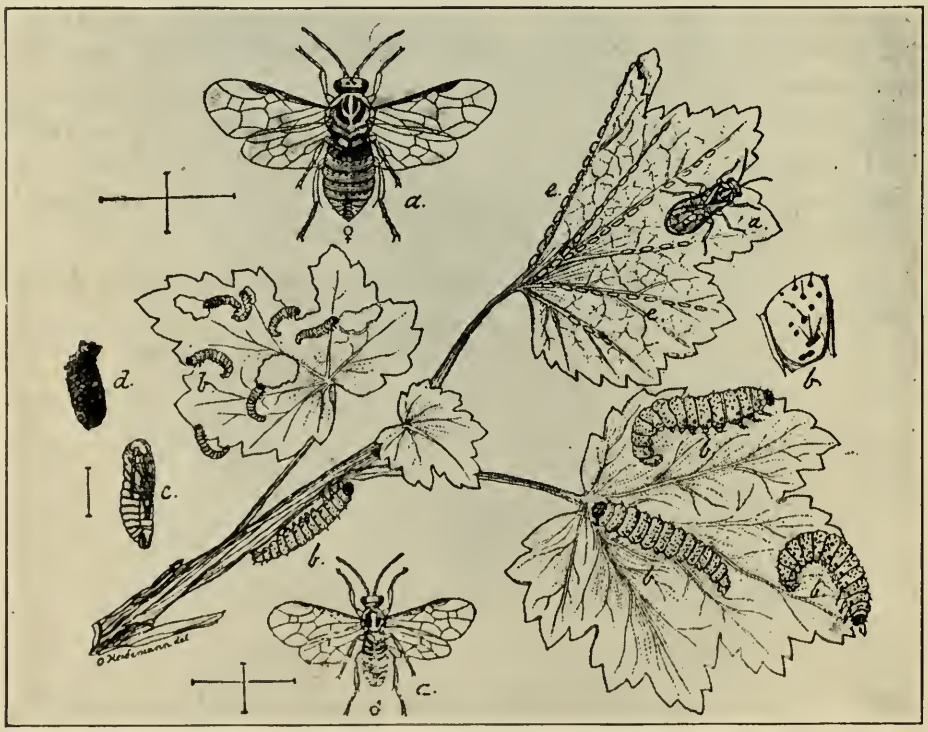
Little can be done in the control of this disease except planting black currants as far away from white pine trees as possible.

THE CHIEF INSECT PESTS OF CURRANTS AND GOOSEBERRIES.

L. Caesar, Provincial Entomologist.

The Currant Worm (*Pteronus ribesii*).—This insect is very common and most years would, if not controlled, strip gooseberries and red and white currants of all or almost all their foliage. It does not, however, attack black currants.

The currant worm is, when full grown, about three-quarters of an inch long. Its colour is bluish green, but the head is black and there are many black spots over the body. The life history of the insect is as follows:—The winter is passed by the worms in firm little oval, earthen cocoons in the ground beneath the plants. In spring about the time the leaves are just beginning to appear flies emerge from these cocoons. These flies are about one-third of an inch long. The female has an orange-yellow coloured abdomen and a black head and thorax. The males are a little smaller than the females and of a general blackish colour. The females begin laying eggs in a few hours after they appear. The eggs are white and are placed in chains on the under side of the leaves along the leaf veins. Most of the eggs are laid on the central or inner leaves; hence when the larvae hatch they feed in the central part of the bush at first and devour the foliage there, often without being noticed by any person. Then when they have grown and are capable of eating the leaves much more rapidly they spread to the outer leaves and quickly destroy these. When full grown they enter the ground and make cocoons. From these in a couple of weeks comes a second brood of flies and from their eggs a second brood of worms. These worms are the ones often seen on the leaves when red currants are ready or nearly ready to pick. Some years there is a small but insignificant third brood.

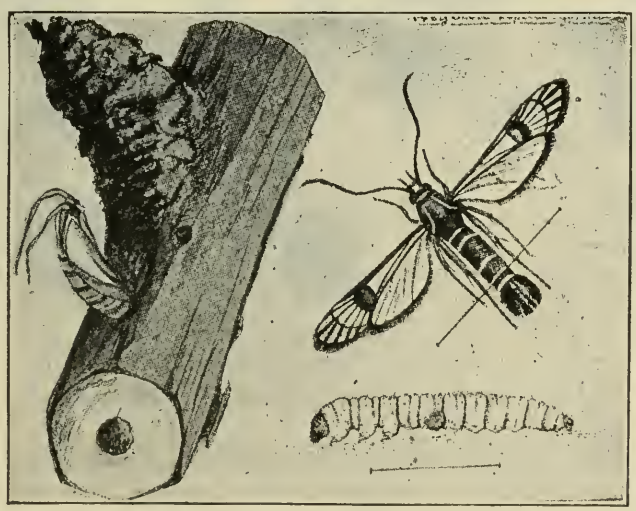


Imported Currant Worm: (*a*) Female and male adults enlarged (the lines to the left show the natural size): (*b*) larvae, those to the left immature, the others about mature; (*c*) pupa enlarged; (*d*) cocoon formed in the soil; (*e*) eggs laid on under surface of leaf. (After Lugger.)

Means of Control.—Spray the plants thoroughly with 1½ pounds arsenate of lead powder to 40 gallons of water or of lime sulphur diluted 1 to 40 or of Bordeaux mixture (3,6,40). The spraying should be done just before the blossoms open, which will be very soon after the leaves have begun to appear. Spray again with the same mixture just after the fruit is set. Remember both times to send the spray right into the centre of the bush where, as said, the larvae feed chiefly at first. If these sprays have been omitted and the larvae are present when the red or white currants are ripening it would be dangerous to use the arsenate of lead; hence substitute for it 1 ounce of hellebore to 1½ gallons of water. The lime sulphur or Bordeaux mixture, mentioned in the regular two sprays, is added solely for the control of fungus diseases.

Black currants are not attacked by the currant worm and therefore do not need to be considered.

THE IMPORTED CURRANT BORER (*Aegeria tipuliformis*).—Currant, and, to a lesser extent, gooseberry plantations are attacked by a borer which works in the canes, especially in the larger ones. Affected canes not infrequently become sickly and in the following season some may even die. The borer is white and is the larva of a clear-winged moth about half an inch in length, blackish in colour with several narrow yellow bands around the body. The moth looks somewhat like a wasp. In Ontario these moths appear in June and may often be seen in considerable number on the leaves. They lay eggs in the axils of the leaves or in any little opening on the canes. The young larvae on hatching



Imported Currant Borer; moth, larva and empty pupae case still attached to exit hole. The dark hole in the end of the cane shows where the larva has tunnelled in the pith. (After Lugger.)

bore into the pith where they feed till full grown. Here they winter. If an infested cane is cut through the darkened pith shows clearly the work of the borers. There is only one brood each year.

Means of Control.—So far as known spraying will not control this pest, and the only practicable means of control seems to be not to grow currants in tree, but in bush form, and to practise a system of pruning by which the wood is not allowed to become old, but is removed after bearing one or at the most two crops, and new shoots allowed to grow up to take the place of those cut out. All prunings must be burned before the end of May, or the moths will emerge

from them. Any dying or sickly canes should also be promptly removed throughout the season and either burned or the borers inside them killed.

THE CURRANT APHIS (*Myzus ribis*).—The leaves of currants and, to a lesser extent, of gooseberries, are often severely attacked by green plant lice (aphids), which feed upon the under surface and cause the leaves to curl downwards. The parts of the upper surface between the veins are usually elevated in large irregular blisters which are often reddish in colour. Affected leaves in many cases are so much weakened that they die. The aphids pass the winter in the egg stage. Eggs are very small, black and glossy and are placed in the axils of the buds. They hatch a few days before the buds burst and the young aphids at once proceed to feed upon the developing buds and leaves. Reproduction in early summer is very rapid, and enormous numbers of the insects may be found. Natural enemies, however, both parasitic and predaceous, usually bring the aphids under control in midsummer.

Means of Control.—Arsenical mixtures are useless as aphids are sucking insects; hence contact poisons must be applied. Of these the best is nicotine sulphate 40 per cent., a tobacco extract. The only objection to this is that it

Currant leaves curled by aphids. (After Close.)

is somewhat expensive. It should be used with lime sulphur (1 to 7) as soon as the eggs have hatched, that is, a day or two before the buds burst. This will destroy most of the insects and, if another application combined with the lime sulphur (1 to 40) or Bordeaux mixture (3, 6, 40) is given just before the blossoms come out, almost every aphid can be destroyed. Of course, in the latter case the spray must be shot up from beneath so that the under surfaces may be covered. The lime sulphur or Bordeaux is added with the object of controlling diseases (see under Leaf-spot above). Whaleoil soap, 1 pound in 6 gallons of water, may be used instead of nicotine sulphate 40 per cent. but should not be combined with lime sulphur. It is almost useless to spray after the leaves have become curled beacuse it is then impossible to hit all or nearly all the aphids.

RED SPIDERS (*Tetranychus bimaculatus*).—Red spiders are mites that feed on the under surface of the leaves of numerous plants. They have sucking mouth parts and cause currant leaves to become brownish or reddish-yellow in colour and therefore unhealthy in appearance. Such leaves in dry weather, when the plants need them most, dry up and die. The mites have the habit

of spinning a very fine web on the under surface of the leaves, beneath the protection of which they feed and lay their eggs. Red spiders are not all red, as one would expect; frequently most of them are a whitish colour. They can just be seen with the naked eye. The eggs are like little glistening drops of dew. The spiders winter in the soil around the base of the plants, and attack the plants in spring soon after the buds burst.

Means of Control.—If lime sulphur is used for the first two spray applications mentioned above and the under surface of the leaves is well covered there should seldom be much trouble from this pest. Wet weather also helps to control it, as the mites thrive best in dry seasons.

San José and Oyster Shell Scales.—Currant bushes frequently, and gooseberry bushes sometimes, are severely attacked by either the San José or Oyster Shell Scale. If no remedial measures are taken the former of these insects will soon kill affected plants, and the latter will weaken them and occasionally cause their death. For a full description of the appearance and habits of these insects see Bulletin No. 219.

Means of Control.—Prune the bushes out well so that every part can be thoroughly sprayed and use lime sulphur, specific gravity strength 1.032 to 1.035 (commercial lime sulphur one gallon to about eight gallons of water), a little while before the buds burst. Soluble sulphur, twelve to fourteen pounds to 40 gallons of water, may be substituted for lime sulphur.

Many other insects attack currants from time to time, but as they seldom do much damage it has not seemed advisable to give an account of them here.